

**CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS
AND ENGINEERING**

**INFRASTRUCTURE
DESIGN MANUAL**



**Michael S. Marcotte, P.E., DEE
Director**

**John J. Sakolosky, P.E.
City Engineer**

**OCTOBER 2002
(Revision 5 – July 28, 2006)**

**City of Houston
Department of Public Works and Engineering**

**INFRASTRUCTURE
DESIGN MANUAL**

**OCTOBER 2002
(Revision 4 – February 1, 2005)**

LIST OF REVISIONS

<u>Revision 1 – June 16, 2003</u>	<u>Page</u>
New “List of Revisions” Page	RP
Edits to Table of Contents	i
Edit to List of Figures.....	ii
Revised Figure 3.4 - Private Project Cover Sheet	3-15
New Figure 3.4 (Continued) - Private Project Signature Block	3-18
Edits to Paragraphs 10.04B 1.a and 10.04B 2.a	10-2
Edit to Paragraph 10.04B 3.a	10-3
 <u>Revision 2 – September 1, 2004</u>	 <u>Page</u>
New “List of Revisions” Page (Previously RP).....	LOR-1
Edits to Table of Contents (Previously i).....	TOC-1
Edits to List of Figures (Previously ii).....	TOC-2
Edits to List of Tables	TOC-3
Change ECRE to Office of City Engineer (OCE)	Various
Remove Note 1 on Table 7.2.....	7-4
Edits to Paragraph 7.03 D 2.c and 7.03 D 2.c (2).....	7-5
Edit to Paragraph 7.03 D 3.a (2).....	7-5
Edit to Paragraph 7.03 D 4.d	7-6
Edits to Paragraphs 7.03 E 1.a and 7.03 E 4	7-7
Edit to Paragraph 7.03 F 1	7-7
Deletion of Paragraph 7.03 F 5.c.....	7-9
Edit to Paragraph 7.03 F 6	7-9
Edits to Table 7.4.....	7-12
Edits to Table 7.5.....	7-13
Addition of Paragraph 9.05 D 3.g	9-10
Edits to Paragraphs 9.05 H 1 and 9.05 H 2.a	9-12
Deletion of Paragraphs 9.05 H 2.c, 9.05 H 2.e and 9.05 H 2.f.....	9-13
Edits to Paragraphs 9.05 H 3.b and 9.05 H 3.c	9-13
Edits to Paragraphs 9.05 H 4.b (1) and (2).....	9-13,14

Revision 3 – October 1, 2004**Page**

New Paragraph 9.02.C inserted	9-1
Old Paragraph 9.02.C renumbered 9.02.D and edited	9-2
Old Paragraph 9.02.D renumbered 9.02.E and edited	9-2
New Paragraphs 9.02.F and 9.02.G added	9-2
New References C, D, E & F added under Paragraph 9.03	9-3
Definitions in Paragraph 9.04 arranged alphabetically	9-3 to 9-5
New term “Development” added to include three types	9-3
New term “New Development” added as subcategory of Development	9-3
New term “HouStorm” added	9-4
Additional “n” value added for concrete boxes	9-4
Rainfall Frequency definitions revised	9-4
Minor edits to Sheet Flow definition	9-5
New term “Structural Flooding” added	9-5
Use of HouStorm added to Paragraph 9.05.A	9-5
Four Subparagraphs added to Paragraph 9.05.A	9-5
Paragraph 9.05.C.1 edited to use defined terms and ECRE renamed ...	9-7 to 9-8
Paragraph 9.05.C.6.c edited to coordinate with Chapter 10	9-9
New Paragraph 9.05.C.6.j inserted	9-11
Old Paragraph 9.05.C.6.j renumbered 9.05.C.6.k	9-11
Old Paragraph 9.05.C.6.k edited and renumbered 9.05.C.6.l	9-11
Old Paragraph 9.05.C.6.l renumbered 9.05.C.6.m	9-11
Additional verbiage added to Paragraph 9.05.D.3	9-11
Paragraph 9.05.D.3.d edited	9-11
Additional verbiage added to Paragraph 9.05.D.3.e	9-12
New Paragraph 9.05.D.3.g added	9-12
Verbiage added to Paragraphs 9.05.F.1.c and 9.05.F.1.d	9-13
Verbiage added and edited in Paragraph 9.05.F.3.c	9-14
Paragraph 9.05.F.3.d edited	9-14
Paragraph 9.05.H.1 edited	9-15
Paragraphs 9.05.H.2.a and 9.05.H.2.b edited	9-15
Paragraph 9.05.H.2.e replaced	9-15
Old Paragraph 9.05.H.2.f deleted	9-15
Paragraph 9.05.H.3 reorganized for different sized Developments	9-16
Both Subparagraphs in Paragraph 9.05.H.4.a edited	9-16
Verbiage and Subparagraphs added to Paragraph 9.05.H.4.b.1	9-17
Edits to Coefficient of Discharge in Paragraph 9.05.H.4.b.2	9-17
Paragraphs 9.05.H.5.b.1 and 9.05.H.5.b.2 edited	9-18
New Paragraph 9.05.H.5.b.5 added	9-18
Paragraph 9.07.B.2 edited	9-19
Paragraph 9.07.B.4 edited and 5 Subparagraphs added	9-19
New Paragraphs 9.07.B.7 and 9.07.B.8 added	9-20
Paragraph 9.07.C.4 edited and 5 Subparagraphs added	9-20
New Paragraph 9.07.C.5 added	9-20

Revision 4 – February 1, 2005**Page**

New “List of Revisions” Page	LOR-3
Edits to Table of Contents	TOC-1
Edits to List of Figures	TOC-2
Edits to List of Tables	TOC-3
Removed “(Sheet Flow)” as being synonymous with “Overland Run-off”	9-1
Added Fort Bend & Montgomery Counties to Paragraph 9.02.G.....	9-2
Added compliance with guidelines in TP-100 to Paragraph 9.05.A.1	9-5
Further defined inlet placement in Paragraph 9.05.C.6.j	9-11
Changed “Sheet Flow” to “overland flow” in Paragraph 9.05.D.1	9-11
Inserted new Paragraph 9.05.D.2 and renumbered remaining paragraphs....	9-11
Removed Caption from newly renumbered Paragraph 9.05.D.4	9-12
Added last sentence to Paragraph 9.05.D.4.d	9-12
Changed Paragraph 9.05.D.4.g to a Caption	9-13
Changed verbiage in Para. 9.05.D.4.g to a subparagraph 9.05.D.4.g(1).....	9-13
Added new Paragraph 9.05.D.4.g(2)	9-13
Added “however” clause to last sentence in Paragraph 9.05.H.2.b	9-16
Added a last sentence to Paragraph 9.05.H.2.e(1)	9-16
Added a last sentence to Paragraph 9.05.H.2.e(2)	9-17
Rearranged Paragraph 9.05.H.3.b and added exemption text on the end	9-17
Changed the word “Same” to “Profile” in Paragraph 9.07.C.5	9-22
Renumbered old pages 9-22 through 9-24.....	9-23 through 9-25



CITY OF HOUSTON

Public Works and Engineering
Department

Lee P. Brown

Mayor

Jon C. Vanden Bosch, P.E.
Director
Public Works & Engineering
Department
P.O. Box 1562,
Houston, Texas 77251-1562

November 26, 2002

www.cityofhouston.gov

TO: Consulting Engineers,
Construction Contractors,
and Developers

RE: Infrastructure Design Manual

Gentlemen:

The City of Houston Department of Public Works and Engineering has officially adopted this updated Infrastructure Design Manual. It provides guidelines for the design of paving and utility projects within the Houston City Limits as well as the design of utility projects within Houston's Extraterritorial Jurisdiction (ETJ). This document is effective as of December 1, 2002.

We recognize that there will be a period of transition covering those projects which are being designed according to criteria contained in the previous edition of this manual. Our various Chief Engineers have, therefore, been authorized to grant variances on a project-by-project basis.

The Department wishes to thank the members of Houston Consulting Engineers Council for their assistance in producing and editing this publication.

Sincerely,

Sincerely,

Showri Nandagiri, P.E.
City Engineer

Jon C. Vanden Bosch, P.E.
Director

JCV:SN:WFP

City of Houston
Department of Public Works and Engineering

INFRASTRUCTURE
DESIGN MANUAL

OCTOBER 2002
(Revision 4 – February 1, 2005)

TABLE OF CONTENTS

<u>Chapter</u>	<u>No. of Pages</u>
1 General Requirements	8
2 Survey Requirements	8
3 Graphic Requirements (Revised 6-16-2003)	18
4 Platting Requirements	6
5 Easement Requirements	6
6 Utility Locations	6
7 Water Line Design Requirements (Revised 9-1-2004)	16
8 Wastewater Collection System Design Requirements.....	15
9 Storm Water Design Requirements (Revised 2-1-2005)	24
10 Street Paving Design Requirements (Revised 6-16-2003)	19
11 Geotechnical Requirements	6
12 Street Cut Requirements	3
13 Storm Water Quality Design Requirements.....	3
14 Facility Design Requirements.....	1

City of Houston
Department of Public Works and Engineering

INFRASTRUCTURE
DESIGN MANUAL

OCTOBER 2002
(Revision 4 – February 1, 2005)

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
2.1 Perimeter of Standard Topographical Survey	2-8
3.1 Existing Improvements	3-5
3.2 Proposed Improvements	3-10
3.3 Line Code Definitions	3-14
3.4 Cover Sheets and Signature Block (Revised 7-28-2006)	3-15
4.1 Class III Preliminary Plats	4-5
4.2 Class III Final Plat (or Class II Plat)	4-6
6.1 Typical Utility Locations in 10-foot-wide Residential Easement	6-5
6.2 Typical Utility Locations in 14-foot-wide Residential Easement	6-6
9.1 City of Houston IDF Curves (Pagination Change)	9-22
9.2 City of Houston Storm Sewer Calculation Form (Pagination Change)	9-23
9.3 City of Houston Roadside Ditch Worksheet (Pagination Change)	9-24
10.1 Divided Roadway Cross Section - Urban	10-11
10.2 Undivided Roadway Cross Section - Urban	10-12
10.3 Typical Length of Median and Median Opening	10-13
10.4 Median Nose and Left Turn Bay Design	10-14
10.5 Intersection Corner Cutback and Curb Return Design	10-15
10.6 Cul-de-sac Design for Street Termination	10-16
10.7 Roadway Tapers for Subdivision Streets	10-17
10.8 Type 2 Permanent Access Easement - Terminus Standard	10-18
10.9 Alleyway of Concrete Pavement Connecting to Curb, Curb and Gutter Street	10-19

City of Houston
Department of Public Works and Engineering

INFRASTRUCTURE
DESIGN MANUAL

OCTOBER 2002
(Revision 4 – February 1, 2005)

LIST OF TABLES

<u>Table</u>	<u>Page</u>
7.1 Water Line Location within a Street Right-of-way.....	7-3
7.2 Depth of Cover for Water Lines.....	7-4
7.3 Length of Restrained Pipe at Dead Ends (Pagination Change)	7-10
7.4 Protection Requirements at Water Line - Sanitary Sewer Crossings	7-12
7.5 Protection Requirements at Water Line - Force Main Crossings	7-13
8.1 Minimum Grades for Wastewater Lines	8-9
8.2 Maximum Distance Between Sanitary Sewer Manholes	8-11
9.1 Standard Storm Sewer Inlets (Pagination Change)	9-10

City of Houston

Design Manual

Chapter 1

GENERAL REQUIREMENTS

Chapter 1

GENERAL REQUIREMENTS

1.01 CHAPTER INCLUDES

- A. Research and submittal requirements for projects inside the city limits of Houston or within Houston's extraterritorial jurisdiction (ETJ).

1.02 REFERENCES

The following references should be reviewed in conjunction with this manual:

- A. Latest revision of the following City of Houston Code of Ordinances:
 - 1. Article IV Chapter 33, City Surveys
 - 2. Chapter 40, Excavation in the Public Way
 - 3. Chapter 42, Developments and Platting Requirements
 - 4. Article V, Chapter 47, Storm Water Quality
- B. Texas Accessibility Standards (TAS) of the Architectural Barriers Act, Article 9102, Texas Civil Statutes.
- C. City of Houston Standard Specifications and Standard Details, latest revision.
- D. Rules and Regulations published by Texas Commission on Environmental Quality (TCEQ).
 - 1. TCEQ, Water Utilities Division, Rules and Regulations for Public Water Systems, latest revision.
 - 2. TCEQ, Design Criteria for Sewerage Systems, Texas Administrative Code, latest revision.
- H. State of Texas Engineering Practice Act.
- I. State of Texas Professional Land Surveying Practices Act.

- J. Storm Water Management Handbook for Construction Activities, Latest Edition as Prepared by Harris County, Harris County Flood Control District (HCFCD), and City of Houston.
- K. Harris County Public Infrastructure Department's Rules and Regulations.

1.03 DEFINITIONS

- A. City Engineer - The authorized representative of the City, or his designee, having approval authority for privately-funded projects, or having authority for administration of design and construction contracts for the City.
- B. Review Authorities - The authorized representatives of City departments, divisions, or sections responsible for reviewing and approving calculations and drawings for privately-funded projects and for design and construction contracts with the City.
- C. Drawings - Plan, profile, detail, and other graphic sheets to be used in a construction contract which define character and scope of the project.
- D. Design Analysis - Narratives and calculations necessary to support design of a project.
- E. Professional Engineer - An engineer currently licensed and in good standing with the Texas Board of Professional Engineers.
- F. Professional Land Surveyor - A surveyor currently registered and in good standing with State of Texas Board of Professional Land Surveying.
- G. Specifications - City of Houston Standard Specifications plus project-specific narrative descriptions of procedures, requirements, and materials for a particular project.

1.04 PLAT AND CONSTRUCTION DRAWING REVIEW PROCESS

- A. Review of plat and construction drawings by the Department of Public Works and Engineering is a required part of the overall platting process under purview of the City Planning Commission and the Planning and Development Department of the City of Houston.
- B. The process to be followed in submitting documents for review and approval of water, wastewater, storm drainage, and street paving is described by the flowchart depicted in Figure 4.1, Review and Approval Process for Plats and Drawings.
- C. Utility and paving construction in projects requiring subdivision plats is not permitted until the final plat has been released. Plat release by Department of Public Works and Engineering is authorized by signature of the Director, or his designee, on final design drawings.

- D. Construction of utilities and paving in projects not requiring a subdivision plat is not permitted until final design drawings are approved and signed by the Director, Department of Public Works and Engineering, or his designee.
- E. Signature of the Director, Department of Public Works and Engineering, or his designee, on final design drawings for utilities which are intended to remain private, does not infer acceptance of the City for ownership or maintenance or operation of facilities indicated on the drawings.

1.05 SUBMITTALS

- A. Submittal Procedures.
 - 1. To obtain review of final design drawings for both publicly-funded and privately-funded projects, first submit drawings to the Public Works and Engineering Plan Review Center for assignment of a log number before review will commence. The log number will remain in effect for one year.
 - 2. Once a log number is assigned, reference the number in all correspondence relating to that project.
 - 3. Obtain and complete plan review application forms for each review phase when the project is logged in. The same log number will be used for all review phases of each project unless review of a subsequent phase is delayed by over one year.
 - 4. Plan Review Center personnel will process reviews through appropriate review teams in the Department of Public Works and Engineering.
 - 5. If a project has begun the review process but becomes inactive for a period of 12 months from the date of the last correspondence, the project will be considered stopped, and the log number inactivated. Upon submittal of a project document for review following the 12-month inactivity period, a new log number will be assigned and the review process re-initiated.
 - 6. The City has a weekly one-day walk-through procedure for the signature stage of small projects. Instruction sheets for this procedure may be obtained in the Plan Review Center.
 - 7. Projects involving construction of privately owned facilities require review and approval of any connection to a public water line, sanitary sewer, or storm sewer or to a public street, using the process defined in this manual.

B. Preliminary Design.

1. Privately-funded Projects: Submit one set of the preliminary overall design concept with supporting evidence as described in Paragraph 1.07 and Paragraph 1.08.
2. Design Contracts with the City: Submit documents in accordance with requirements of the professional engineering services contract.

C. Final Design.

1. Privately-funded Projects:
 - a. Submit one set of the final design drawings with prints containing preliminary review comments.
 - b. For complex projects, it is recommended that a copy of the City review comments on the preliminary drawings be returned with the revised final design drawings.
2. Design Contracts with the City:
 - a. Submit documents in accordance with requirements of the professional engineering services contract.
 - b. Submit a copy of the City review comments on the preliminary drawings.

D. Signature Stage.

1. Submit original tracings with prints containing previous review comments.
2. Specification submittals:
 - a. Submit final design specifications for review on all City funded projects.
 - b. Provide notes on plans for all privately funded projects stating that all facilities shall be constructed in accordance with City of Houston Standards.
3. On City projects, submit final computer-generated drawing files in acceptable electronic media including vicinity maps, right-of-way drawings, construction drawings, or other information pertinent to the project. Submit surveyor's field book and electronic data in accordance with Chapter 2, Survey Requirements.

4. On privately funded projects, submit final computer generated drawing files in acceptable electronic media including plat, right-of-way maps, and construction drawings. Scanned images may be acceptable if project is less than 3 sheets.

1.06 QUALITY ASSURANCE

- A. Have surveying and platting accomplished under direction of a Professional Land Surveyor.
- B. Have recording documents sealed, signed, and dated by a Professional Land Surveyor.
- C. Have calculations prepared by or under the direct supervision of a Professional Engineer trained and licensed in disciplines required by the project scope.
- D. Have final design drawings sealed, signed, and dated by the Professional Engineer responsible for development of the drawings.

1.07 RESEARCH REQUIREMENTS

- A. Research existing utility and right-of-way information with the City departments listed below. Present and discuss the concept of the project with these same departments.
 1. Department of Aviation
 2. Department of Public Works and Engineering
 - a. Engineering, Construction and Real Estate Division. |
 - b. Engineering, Construction and Real Estate Division File Room Section |
 - c. Maintenance and Right-of-Way Division, Traffic Management and Maintenance Branch
 - d. Public Utilities Division, Utility Analysis Section
 3. Planning and Development Department
 4. Parks and Recreation Department
 5. Finance and Administration Department, Franchise Administration
- B. Research existing utilities and rights-of-way or easements for conflicts with the following public and private organizations:
 1. Texas Department of Transportation

2. Harris County Public Infrastructure Department
3. Harris County Toll Road Authority
4. Other County Governments
5. Franchise Holders:
 - a. Reliant Energy - Entex
 - b. Reliant Energy - HL & P
 - c. Southwestern Bell Telephone
6. Cable television and data communications companies
7. Other utility companies:
 - a. Utility districts
 - b. Private utilities/franchises
 - c. Railroad companies
 - d. Pipeline companies

- C. Verify that no restrictions or conflicts exist that will prevent approval and permitting of the project.

1.08 DESIGN REQUIREMENTS

A. Preliminary Design.

1. Privately-funded Projects:
 - a. Prior to preliminary design submittal, City reviewers are available to discuss alternate solutions for project elements where alternate designs may be considered.
 - b. Provide the City Engineer with drawings in sufficient detail to describe the proposed improvements. Include proposed materials, if different from materials approved by the City. Identify any problems or conflicts associated with the project. Information furnished must be in sufficient detail for the City Engineer to assess whether the design meets current City design standards.

- c. Provide rights-of-way and easement requirements for the project.
- 2. Design Contracts with the City:
 - a. Participate in preliminary conferences with the City Engineer outlining the scope of work and extent of the preliminary report.
 - b. Prepare preliminary engineering studies and designs based upon the scope of work and as outlined in the professional engineering services contract with the City.
 - c. Prepare the contractually specified number of copies of preliminary layouts, sketches, reports, and calculations supporting the preliminary layouts. Prepare alternate solutions, where applicable to the project, and include the engineer's specific recommendations.
 - d. Prepare preliminary cost estimates for primary and alternate solutions of the proposed construction.
 - e. Participate in conferences with the City to determine final design.
 - f. When required by the professional services contract, provide detailed soils and geotechnical investigations and environmental investigations to support proposed construction of utilities and paving.
 - g. Provide required real estate, rights-of-way, and easement requirements for the project.

B. Final Design.

- 1. Privately-funded Projects:
 - a. Revise design to reflect comments of the City Engineer and review authorities. Include design calculations to support proposed improvements.
 - b. Provide review prints to the City Engineer and review authorities for verification and compliance with prior review comments.
 - c. Obtain required signatures from governmental agencies (other than the City of Houston) and private utility companies prior to requesting signature by the City.
 - d. Include the following note on construction drawings - "Contractor shall notify the City of Houston, Department of Public Works and Engineering (713-837-7000) 48 hours before starting work on this project."

2. Design Contracts with the City:
 - a. Furnish the City, where applicable, engineering data necessary for applications for routine permits required by local, state, and federal authorities.
 - b. Prepare detailed final design drawings and specifications in compliance with comments received from the City subsequent to the review of the preliminary design.
 - c. Prepare detailed cost estimates and proposal forms for the authorized project.

C. Original Tracings.

1. Approved drawings for projects within the city limits will be assigned a City drawing number and must be filed in the City file room prior to issuance of a permit for construction. Tracings will become property of the City and will remain on file in the file room for use by any person who may be interested in the project.
2. Approved drawings for projects outside of city limits and within the City ETJ will be returned to applicant.

END OF CHAPTER

City of Houston

Design Manual

Chapter 2

SURVEY REQUIREMENTS

Chapter 2

SURVEY REQUIREMENTS

2.01 CHAPTER INCLUDES

- A. Suggested guidelines for use by engineers in development of construction drawings and right-of-way maps inside the Houston city limits and outside the Houston city limits within the ETJ. These guidelines are required for Capital Improvement Projects designed under professional services contracts with the City of Houston.

2.02 REFERENCES

- A. Article IV, Chapter 33, City Surveys, of the Code of Ordinances.
- B. Professional Land Surveying Practices Act, latest revision.

2.03 DEFINITIONS

- A. Survey Field Books - Bound standard engineer's field books for transit and level, 7-1/4 inch by 4-3/4 inch.
- B. Data Collection Base - A database printout file reflecting station occupied, backsight, point number, angle, distance, elevations, and identification code; or station and offset left and right from a centerline or control line (transit, baseline, traverse, survey, etc.).
- C. City Surveyor - An authorized representative of the City having approval authority for privately-funded projects or having authority for administration of contracts for the City.
- D. GPS - Navigational System operated by US Department of Defense. When used with proper equipment, can provide survey quality locations in terrestrial space.
- E. Site Control Monuments - Monuments needed to augment existing City monuments, conforming to standards established by the City Surveyor.

2.04 DESIGN REQUIREMENTS

- A. Adhere to these guidelines for Capital Improvement Projects designed under professional services contracts with the City of Houston.

2.05 SUBMITTALS

- A. For work performed through a professional service contract with the City, deliver field books and an electronic file in standard ASCII format (Point Number, Northing, Easting, Elevation, Description) at completion of the design phase. Photocopies or carbon copies of field books are not acceptable. Field books and electronic files will be retained in the City's permanent files.
- B. For right-of-way drawings identifying or describing acquisition of new or additional rights-of-way, deliver field books and database printout files to the City Surveyor or a designee of the City Surveyor. Additional documents to be submitted are:
 - 1. Overall map of rights-of-way with individual drawings of parcels identified on overall maps. Map or drawing media shall be mylar.
 - 2. Computer printouts of coordinate computations.
 - 3. Abstract information and copies of instruments used (i.e., deed) in preparation of the right-of-way maps.
- C. For projects requiring new Site Control Monuments, the surveyor responsible for setting the monuments shall submit sealed City monument sheets, with necessary supporting data, to the City Survey Office

2.06 QUALITY ASSURANCE

- A. Field surveying used in the development of construction drawings, calculations and preparation of right-of-way maps, and field note descriptions shall be performed by or under the direct supervision of a Professional Surveyor.
- B. Surveys shall comply with the latest revision of the Professional Land Surveying Practice Act of the State of Texas.
- C. Field notes, descriptions and right-of-way maps shall have the imprinted or embossed seal of the responsible Professional Surveyor and shall be dated and signed by the Professional Surveyor.
- D. When establishing horizontal control, surveyors shall transcribe onto the pages of a standard Survey Field Book, as described in Paragraph 2.03.A, all angles and distances, at the time of measurement, with an accompanying sketch. When establishing vertical control, the surveyor shall use differential leveling, or GPS methods, and transcribe the vertical data onto the pages of a standard Survey Field Book, with an accompanying sketch.

- E. For projects where the horizontal control exceeds a distance of 2,000 feet from a found City of Houston monument, a Site Control Monument shall be set. Additional Site Control Monuments shall be set should the horizontal control exceed a radial distance of 2,000 feet from an existing City monument or newly set Site Control Monument. Obtain City monument designation numbers from the City Survey Office.

2.07 FIELD WORK

- A. For engineering contracts with the City, field work shall be recorded in field books or on total station database printouts. Obtain a field book number from the Survey Section or City Engineer and record this identification in the title block on drawing sheets.
- B. The control line must be monumented at its beginning, end, and at angle points with markers of a permanent nature, such as iron rods, spikes, or other lasting identification. Make reference drawings for each control monument showing ties to planimetric features to allow easy recovery. Set markers at a maximum of 1000 feet on long lines.
- C. Make ties of the found right-of-way monuments and property corners to the control line according to the existing City of Houston survey system, as required by Article IV, Chapter 33, City Surveys, of the Code of Ordinances.
- D. Use City datum for elevations when available. Set temporary bench marks (TBM) within 200 feet of the beginning and end of the project and at intervals not to exceed 1000 feet throughout the project.
- E. Show centerlines and angles of intersections of side streets with the main roadway centerline station.
- F. Record topographic features within the public right-of-way, proposed right-of-way, any contiguous easements to the right-of-way, and any construction right-of-way of the project and on intersecting streets for a distance of 20 feet beyond the intersection of the right-of-way lines. Identify all visible underground structures, such as inlets, manholes, and junction boxes, with size, depth, and type.
- G. Cross sections shall be taken at intervals of 100 feet for projects outside of the CBD. For projects within the CBD, take cross sections at 25 or 50 foot intervals. For levels recorded in field books, record rod readings or elevations as numerator and distance right or left of the base or centerline as the denominator. Data collector of a total station can be used to acquire necessary elevations at required intervals. Record elevation of driveways at intersection of driveway centerline with existing or proposed right-of-way line. Cross sections shall include a reading at the following points: street centerline, flow-line of ditch or gutter, curb or pavement edge, sidewalk, the existing or proposed right-of-way line, 20 feet beyond the right of way line if possible, and on intersecting streets for a distance of 100 feet beyond proposed pavement. See Figure 2.1 Perimeter of Standard Cross Section Survey.

H. For acquisition of new or additional rights-of-way:

1. Tie points of commencing (POCs) or points of beginning (POBs) for each parcel to the City survey monuments, if within 2,000 feet of the parcel. In the event any one parcel in the right-of-way is within 2,000 feet of a City monument, tie all parcels to the monument.
2. For projects more than 2,000 feet from a City survey monument, and where Site Control Monuments are not established, job coordinates will be permitted with the origin of coordinates shown and monumented on the map. The assumed coordinate system must leave no question as having any relationship to true "x," "y" using the Texas State Plane Coordinate System.
3. Set iron rods or permanent markers at the intersections of the proposed right-of-way and property lines of parcels to be acquired.
4. Identify monuments, corners, angle points, points of curve (PCs), points of intersection (PIs), points of tangency (PTs), and other points as either "found" or "set." Describe each point such as 5/8-inch iron rod, 3/4-inch iron pipe, axle, concrete marker, disk, or other item.
5. Locate improvements, buildings, fences, permanent signs, and other structures within the parcel or within 10 feet of the proposed right-of-way that will influence the value of the parcel to be acquired.

2.08 CALCULATIONS

- A. Calculate coordinates of proposed right-of-way parcels, control points, found or set monuments, curve data, lengths, stations and offsets to monuments, and proposed improvement features. Calculate areas, cross sections, and volumes associated with construction drawings.
- B. Computer printouts of the coordinate calculations should be submitted to the City with field books and database printout files.

2.09 CONSTRUCTION DRAWINGS

- A. Found existing right-of-way monuments or property corners must be plainly shown on the drawings and located by station and distance, right or left from the control line, or construction centerline. Monuments used to establish the control line must be identified as Control Points, and their relationship to the construction centerline and to the proposed or existing right-of-way lines must be shown. If the project is dimensioned from a control line, such as construction or design baseline, which is different than the control line referenced in Paragraph 2.07, it must be established and monumented in accordance with the requirements

of Paragraph 2.07. Coordinates for transverse control points and all points of curve, points of tangency, and points of intersection along the design baseline shall be shown.

- B. Show location and identification of existing City survey monuments, right-of-way monuments, and found property corners by station and distance, right or left of control line or centerline. Show swing ties set for control or centerline control.
- C. Show and identify location of the City datum monuments and temporary bench marks used for elevation control with year of the City datum on each sheet of the drawings. List the TBM located closest to that particular sheet in a station/offset, description and elevation format.
- D. Show centerline angles of intersection of side streets with main roadway centerline. Where bearings are used, identify source of bearings and show bearings on both control line and project centerline when they are not the same line.
- E. Identify locations of manholes, angle points, bends, etc., for proposed wastewater, storm sewers, water lines, and pavement features such as radius returns and centerlines of boulevard openings. Show relationship of proposed improvements to the right-of-way line.
- F. For bridges, overpasses and underpasses, show top of pavement elevations at gutter line and centerline for the following locations:
 - 1. Construction joints
 - 2. Armor or expansion joints
 - 3. Intervals between bents that correspond to the increments used for dead load deflection calculations.
- G. For bridges and grade separations, drawings must incorporate layout sheets which identify proposed centerline and curve information plus:
 - 1. Surface coordinates for control points so that an inverse between coordinates reflects a surface distance. Identify origin of coordinate system used.
 - 2. Show coordinates of centerline or control line at PIs.
 - 3. Show coordinates of curb lines at their intersection with the centerline of bents and abutments for irregular structures.

2.10 RIGHT-OF-WAY MAPS

- A. Show true "x," "y" values (i.e., grid) on monuments based on the City survey control and the scale factor used to determine the "x," "y" values. Distances shown shall be surface distances

and plainly marked as such. Show ties to the POC or POB of each right-of-way parcel from the City survey monuments using the Texas Plain Coordinate System bearings and surface distances.

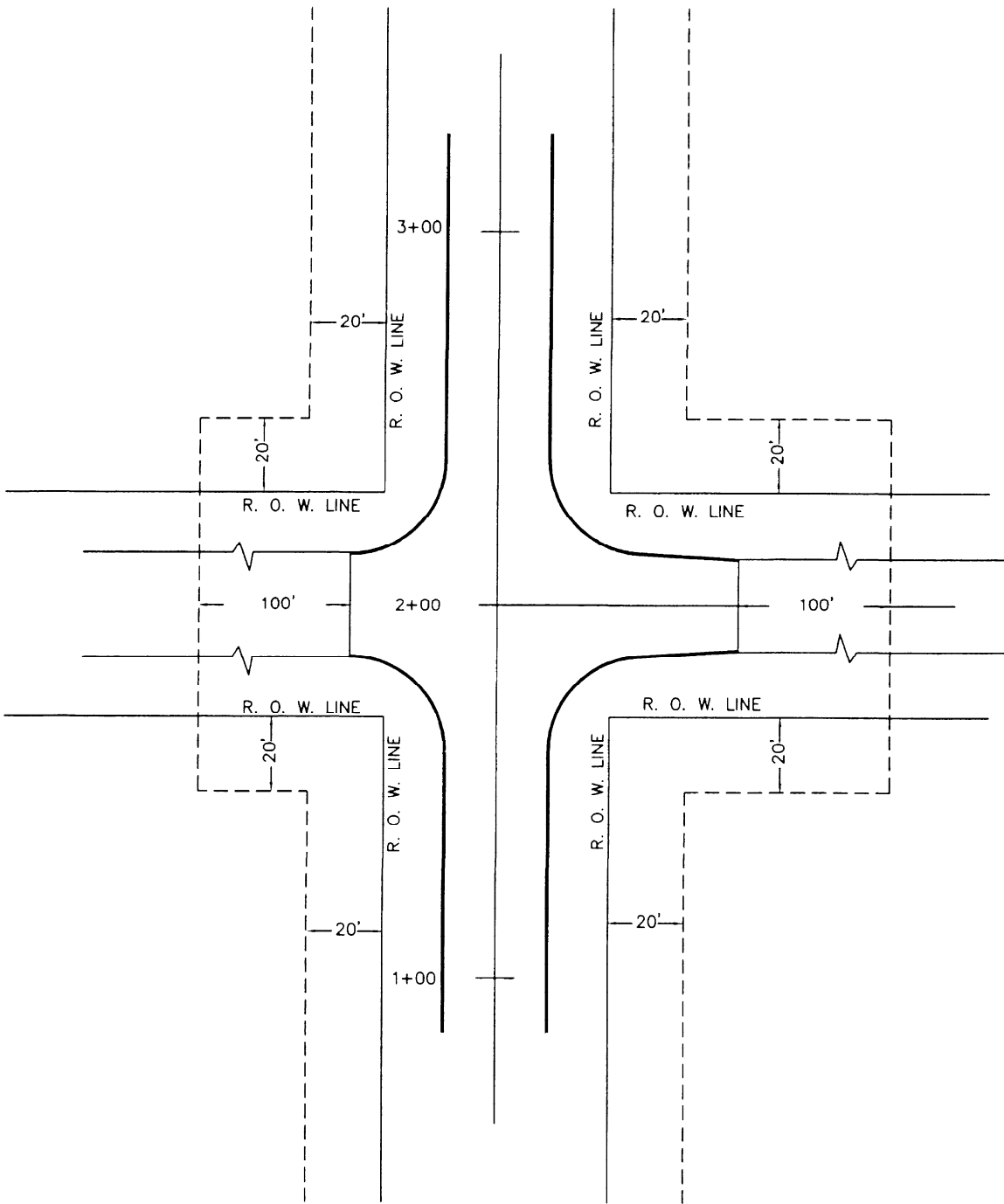
- B. Surveyors may use assumed coordinates on projects located more than 2,000 feet from existing City of Houston monuments, when Site Control Monuments are not established. Show location of monuments used as origin of job coordinates. The assumed coordinate values must leave no question as to their relationship with the true "x," "y" using the Texas State Plain Coordinate System.
- C. Distances on proposed right-of-way lines shall be continuous from beginning to end of the job. Show either straight line or arc distance across intersecting streets.
- D. Where a parcel is taken from a larger tract, show dimensions, distances, and area of the remainder of the tract based on recorded information.
- E. Identify the evidence used to decide the final placement or establishment of the proposed right-of-way line, such as angle points, or corner monuments, as either "set" or "found." The description of each point used shall be shown on the drawing as identified in the field survey.
- F. Coordinate values of "x," "y" shall be shown for PCs, PTs, and PIs of curves on the proposed right-of-way lines. Curve data must include the following: delta, radius, arc length, chord length, and chord bearing.
- G. Coordinate values of "x," "y" must be given on the POB of at least one tract in each block. Where the proposed right-of-way is to be acquired from a large tract of land, coordinate values should be given for the POB of field note description of the large tract.
- H. Other information to be shown on right-of-way maps:
 - 1. Improvements such as buildings, fences, permanent signs, and other structures located on the property or within 10 feet outside the right-of-way line that will influence the value of the parcel to be acquired.
 - 2. Abstract information used in preparation of the right-of-way map.
 - 3. Field book numbers obtained from the City Surveyor.
 - 4. Real estate numbers obtained from the City Surveyor, right-of-way engineer, or Real Estate Division.

2.11 DOCUMENTS

- A. Where new construction will damage, destroy, or alter existing survey markers, include in specifications a requirement for installation of survey marker boxes by construction contractor at a unit price per box. The City Surveyor will determine the number and location of boxes to be furnished and installed by the contractor.
- B. Maps and metes and bounds field notes shall have the Professional Surveyor's seal imprinted or embossed on them and shall have the Professional Surveyor's signature and date affixed to the instrument.

END OF CHAPTER

FIGURE 2.1
PERIMETER OF STANDARD
TOPOGRAPHICAL SURVEY



City of Houston

Design Manual

Chapter 3

GRAPHIC REQUIREMENTS

Chapter 3

GRAPHIC REQUIREMENTS

3.01 CHAPTER INCLUDES

- A. Graphic requirements for engineering drawings.

3.02 REFERENCES

- A. City of Houston monument ties in compliance with Article IV, Chapter 33, City Surveys, of the Code of Ordinances.

3.03 DEFINITIONS

- A. Computer Aided Drafting Design (CADD) - Preparation of drawings, plans, prints, and other related documents through the use of computer equipment and software programs.

3.04 DESIGN REQUIREMENTS

- A. Provide a cover sheet for projects involving three or more design drawings (excluding standard City of Houston detail sheets). Drawing sheet numbers and titles shall be listed on the cover sheet. Include an area key map and vicinity map to identify project location.
- B. Drawings shall be prepared on 23" x 36" Federal Aid Sheets, 22" x 34" ANSI standard drawing sheets, or nominal 24" x 36" drawing sheets, as appropriate.
- C. Show service area on cover sheet or area map.
- D. Final design drawings shall be India ink on mylar, or produced by CADD on mylar using non-water based ink. Do not use adhesive-backed material on final drawings. Stick-ons may be allowed with approval of the City Engineer for a minor correction during the final review process.
- E. Details of special structures (not covered by approved standard drawings, such as stream or gully crossings, special manholes, or junction boxes) shall be drawn with vertical and horizontal scales equal to each other.
- F. Each set of engineering drawings shall contain paving and utility key drawings indexing specific plan and profile sheets. City Standard Details, where applicable, shall be included. All sheets shall have standard title blocks. Where applicable, show HCFCD key drawings and numbers.
- G. Draw key overall layouts to a minimum scale of 1" = 200'.

- H. Plan stationing must run from left to right, except for short streets or lines originating from a major intersection, where the full length can be shown on one sheet.
- I. A north arrow is required on all sheets and should be oriented either toward the top or to the right. This requirement is waived under the following conditions:
1. A storm water or sanitary sewer with flow from west to east or from south to north.
 2. A primary outfall drainage ditch with flow from west to east or from south to north.
 3. Stationing is intended to start from the cardinal points of the compass and proceed in the direction of construction.
- J. Standard scales permitted for plans and profiles of paving and utility construction drawings are as follows:
1. Major thoroughfares, streets with esplanades over 400 feet in length, or special intersections/situations.

1" = 20' Horizontal, 1" = 2' Vertical
 2. Minor or residential single-family streets.

1" = 20' Horizontal, 1" = 2' Vertical
1" = 50' Horizontal, 1" = 5' Vertical, or
1" = 40' Horizontal, 1" = 4' Vertical
 3. Scales of Paragraph 3.04J.2 above are minimum; larger scales may be used to show details of construction.
 4. Deviation from specified scales can only be permitted with the special approval of the project manager or section head.
 5. Single-banked plan-and-profile drawings are acceptable; double-banked plan-and-profile sheets are allowed in certain situations such as off-site utility lines in undeveloped areas.
- K. Show ties on drawings to City monuments when applicable; otherwise, make a statement on the cover sheet referencing assumed control coordinates.
- L. Each sheet of the plan and profile shall have a benchmark elevation and description defined.
- M. The seal, date, and original signature of the Professional Engineer responsible for the drawings is required on each sheet developed by the design engineer. The design engineer may use stamped seal or embossed imprint; however, the embossed imprint must be shaded so that it will reproduce on prints.

- N. A copy of the final plat for new development shall be included with the final design drawings when submitted for final approval.
- O. If a roadway exists where drawings are being prepared to improve or construct new pavement or a utility, label the existing roadway width, surfacing type, and thickness.
- P. Show all street and road alignments on drawings.
- Q. Develop drawings to accurate scale showing proposed pavement, typical cross sections, details, lines and grades, and existing topography within street right-of-way, and any easement contiguous with the right-of-way. At the intersection, the cross street details shall be shown at sufficient distance (20-foot minimum distance outside the primary roadway right-of-way) in each direction along cross street for designing adequate street crossings.
- R. Match lines between plan and profile sheets shall not be placed or shown within cross street intersections including cross street right-of-way.
- S. Show natural ground profiles as follows:
 - 1. For privately-funded projects, centerline profiles are satisfactory except where a difference of 0.50 feet or more exists from one right-of-way or easement line to the other, in which case, dual profiles are required.
 - 2. For City projects, provide natural ground profiles for each right-of-way line. Easement profiles shall conform to Paragraph 3.04T.1.
- T. Basic plan and profile sheets shall contain the following information:
 - 1. Identify lot lines, property lines, easements, rights-of-way, and HCFCF outfalls.
 - 2. Label each plan sheet as to street/easement widths, pavement widths, pavement thickness where applicable, type of roadway materials, curbs, intersection radii, curve data, stationing, existing utilities (type and location), and any other pertinent feature affecting design.
 - 3. Show utility lines 4 inches in diameter or larger within the right-of-way or construction easement in profile view. Show utility lines, regardless of size, in the plan view, including communication and fiber optic cables.
 - 4. Graphically show flow line elevations and direction of flow for existing ditches.
 - 5. Label proposed top of curb grades except at railroad crossings. Centerline grades are acceptable only for paving without curb and gutters.
 - 6. Show in profile curb return elevations for turnouts.

7. Gutter elevations are required for vertical curves, where a railroad track is crossed.
 8. For street reconstruction projects, show in profile the centerline elevation at the property line of existing driveways.
 9. Show both existing and proposed station esplanade noses or the centerline of esplanade openings, including esplanade width.
 10. The design of both roadways is required on paving sections with an esplanade.
 11. Show in plan view station PCs, PTs, and radius returns. Show in profile station radius returns and grade change PIs with their respective elevations.
- U. For plant work, use a grid system to locate proposed work.

3.05 GRAPHIC STANDARDS

- A. The following graphic standards for plan and profile shall apply to drawings of 1" = 20' scale. For smaller scale drawings, use proportionally smaller line sizes.
- B. Existing Improvements: The standards shown in Figure 3.1, Existing Improvements, are required for depicting existing improvements on base drawings. Use lower case letters with a No. 0 reprographic pen or equal line weight unless otherwise shown in the pen/line weight table, Figure 3.3, Line Code Definitions. Smaller pen sizes for lettering may be used for clarity.
- C. Proposed Improvements: The standards shown in Figure 3.2, Proposed Improvements, are required for depicting proposed improvements on base drawings. Use upper case letters with a No. 3 reprographic pen or equal line weight unless shown otherwise in the pen/line weight table, Figure 3.3, Line Code Definitions. Smaller pen sizes for lettering may be used for clarity.
- D. Signature Block: Use latest edition of Signature Blocks issued by the Engineering, Construction and Real Estate Division for private and City projects.

END OF CHAPTER

FIGURE 3.1
EXISTING IMPROVEMENTS
PLAN VIEW

TEXT FOR EXISTING IMPROVEMENTS SHALL NOT BE SMALLER THAN 60 LEROY

		WT	LC
ROW LINE		3	0
PROPERTY LINE		3	0
THEORETICAL PROPERTY LINE		3	0
LOT LINES		1	0
EASEMENT LINE		0	2
CENTER LINE OF ROW		0	4
TRANSIT LINE		0	0
EDGE OF DITCHES		0	0
CENTER LINE OF DITCHES		0	2
EDGE OF DITCHES		0	0
FENCE LINE, WOOD		0	0
FENCE LINE, CHAIN LINK		0	0
FENCE LINE, BARBED WIRE		0	0
FENCE LINE, HOG WIRE		0	0
EDGE OF CONCRETE		0	0
CURB LINE		0	0
EDGE OF ASPHALT		0	0
EDGE OF SHELL OR GRAVEL		0	2
DIMENSION LINE		0	0
HL&P AERIAL LINE		0	0
HL&P UNDERGROUND LINE		0	6
GAS LINE		0	1
MISC UNDERGROUND LINES		0	8

WT	K & E PEN NO	LINE WEIGHT/WIDTH	METRIC
0	0	0.014"	0.35mm
1	1	0.020"	0.50mm
2	2	0.024"	0.60mm
3	3	0.031"	0.80mm
6	6	0.055"	1.40mm

LEGEND:

WT LINE WEIGHT
LC LINE CODE

FIGURE 3.1 (CONTINUED)
EXISTING IMPROVEMENTS
PLAN VIEW

TEXT FOR EXISTING IMPROVEMENTS SHALL NOT BE SMALLER THAN 60 LEROY

		WT	LC
PIPELINE OR WESTERN UNION CONDUIT	(IDENTIFY CONDUIT)	0	1
SWBT CONDUIT		0	2
CABLE TV		0	2
MATCH LINE		3	0
RAILROAD LINE		0	0
WATER LINE	24" (AND SMALLER) WATER 30" (AND LARGER) WATER	0	7
WASTEWATER SEWER LINE	24" (AND SMALLER) WASTEWATER SEWER 30" (AND LARGER) WASTEWATER SEWER	0	3
STORM SEWER LINE	24" (AND SMALLER) STORM SEWER 30" (AND LARGER) STORM SEWER	0	0
IRON PIPE OR IRON ROD MONUMENTS	3/4" IP	0	0
POINT OF INTERSECTION (PI)		0	0
POINT OF CURVE (PC) POINT OF TANGENCY (PT)		0	0
POWER POLE		0	0
POWER POLE W/DOWN GUY		0	0
GAS METER	GM	0	0
GAS VALVE	GV	0	0
MISC UNDERGROUND PIPELINE LABEL	A2	0	0

WT	K & E PEN NO	LINE WEIGHT/WIDTH	METRIC
0	0	0.014"	0.35mm
1	1	0.020"	0.50mm
2	2	0.024"	0.60mm
3	3	0.031"	0.80mm
6	6	0.055"	1.40mm

LEGEND:

WT LINE WEIGHT
LC LINE CODE

FIGURE 3.1 (CONTINUED)
EXISTING IMPROVEMENTS
PLAN VIEW

TEXT FOR EXISTING IMPROVEMENTS SHALL NOT BE SMALLER THAN 60 LEROY

		WT	LC
PAVING HEADER		0	0
BUILDING, RESIDENTIAL		0	0
BUILDING COMMERCIAL		0	0
TREE (RADIUS OF TREE CANOPY SHALL BE 1 FOOT FOR EACH INCH OF TRUNK DIAMETER)		0	0
HEDGE		0	0
WATER METER		0	7
WATER VALVE (GATE)		0	7
WATER VALVE (BUTTERFLY)		0	7
FIRE HYDRANT/FLUSHING VALVE		0	7
TAPPING SLEEVE & VALVE		0	7
REDUCER			


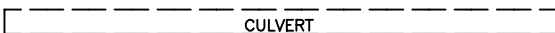
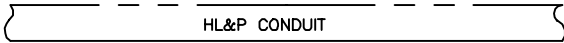
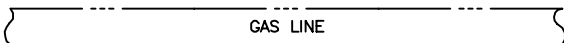
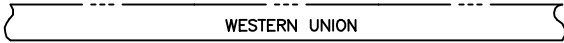
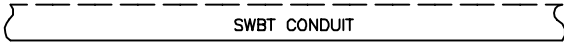
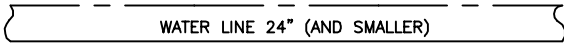
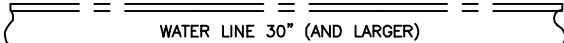
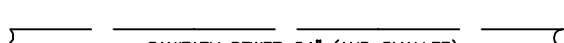
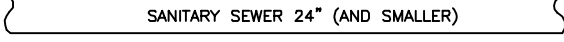
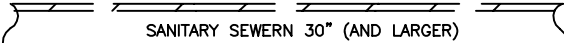

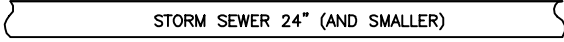
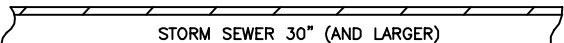
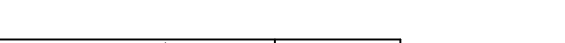
WT	K & E PEN NO	LINE WEIGHT/WIDTH	METRIC
0	0	0.014"	0.35mm
1	1	0.020"	0.50mm
2	2	0.024"	0.60mm
3	3	0.031"	0.80mm
6	6	0.055"	1.40mm

LEGEND:

WT LINE WEIGHT
LC LINE CODE

FIGURE 3.1 (CONTINUED)
EXISTING IMPROVEMENTS
PROFILE VIEW

TEXT FOR EXISTING IMPROVEMENTS SHALL NOT BE SMALLER THAN 60 LEROY

		WT	LC
NORTH OR EAST PROPERTY LINE	_____	1	5
SOUTH OR WEST PROPERTY LINE	_____	1	6
NORTH OR EAST CURB	_____	1	7
SOUTH OR WEST CURB	_____	1	3
NORTH OR EAST DITCH	_____	1	7
SOUTH OR WEST DITCH	_____	1	3
NORTH OR EAST CULVERT		1	2
SOUTH OR WEST CULVERT		1	2
CENTERLINE OF ROW	_____	1	0
HL&P CONDUIT		1 1	6 0
GAS LINE		1 1	1 0
WESTERN UNION		1 1	1 0
SWBT CONDUIT		1 1	2 0
WATER LINE		1	7
		1	0
		1	7
WASTEWATER SEWER LINE		1	3
		1	0
		1	0
STORM SEWER LINE		1	0
		1	0
		1	0

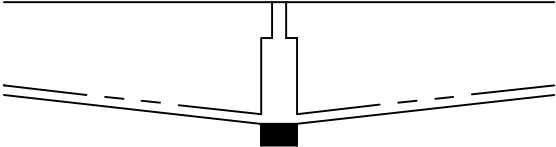
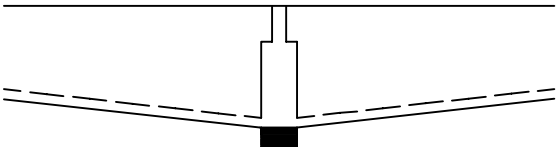
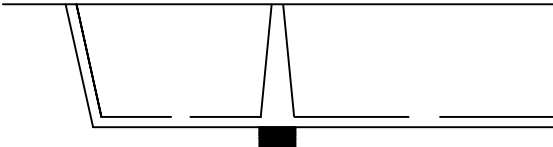
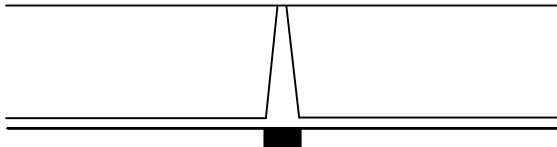
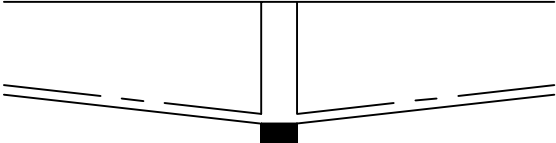
WT	K & E PEN NO	LINE WEIGHT/WIDTH	METRIC
0	0	0.014"	0.35mm
1	1	0.020"	0.50mm
2	2	0.024"	0.60mm
3	3	0.031"	0.80mm
6	6	0.055"	1.40mm

LEGEND:

WT LINE WEIGHT
LC LINE CODE

FIGURE 3.1 (CONTINUED)
 EXISTING IMPROVEMENTS
 PROFILE VIEW

TEXT FOR EXISTING IMPROVEMENTS SHALL NOT BE SMALLER THAN 60 LEROY

		<u>WT</u>	<u>LC</u>
HL&P MANHOLE		1	6
SWBT MANHOLE		1	2
SANITARY SEWER MANHOLE & CLEANOUT		1	3
STORM SEWER MANHOLE		1	0
WATER LINE MANHOLE		1	7

WT	K & E PEN NO	LINE WEIGHT/WIDTH	METRIC
0	0	0.014"	0.35mm
1	1	0.020"	0.50mm
2	2	0.024"	0.60mm
3	3	0.031"	0.80mm
6	6	0.055"	1.40mm

LEGEND:

WT LINE WEIGHT
 LC LINE CODE

FIGURE 3.2
PROPOSED IMPROVEMENTS – WATER LINES
PLAN VIEW

TEXT FOR PROPOSED IMPROVEMENTS SHALL NOT BE SMALLER THAN 100 LEROY

		WT	LC
WATER LINE	24" (AND SMALLER)	3	7
	WATER LINE 30" (AND LARGER)	3	7
WATER VALVE (GATE)	WV	3	7
WATER VALVE (BUTTERFLY)	BFV	3	7
TAPPING SLEEVE & VALVE	TS&V	3	7
FIRE HYDRANT/FLUSHING VALVE	FHY/FV		
	WV	3	7
REDUCER	12" 8"	3	7
ROUND CONNECTION		3	7

PROPOSED IMPROVEMENTS – WATER LINES
PROFILE VIEW

TEXT FOR PROPOSED IMPROVEMENTS SHALL NOT BE SMALLER THAN 100 LEROY


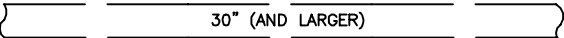
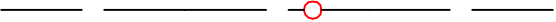
		WT	LC
WATER LINE	WATER LINE 24" (AND SMALLER)	3	7
		3	0
	WATER LINE 30" (AND LARGER)	3	7
		3	0

WT	K & E PEN NO	LINE WEIGHT/WIDTH	METRIC
0	0	0.014"	0.35mm
1	1	0.020"	0.50mm
2	2	0.024"	0.60mm
3	3	0.031"	0.80mm
6	6	0.055"	1.40mm

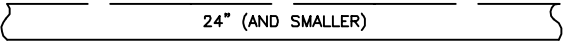
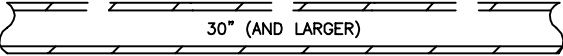
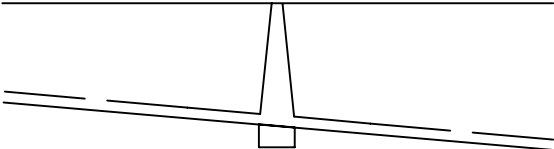
LEGEND:

WT LINE WEIGHT
LC LINE CODE

FIGURE 3.2 (CONTINUED)
PROPOSED IMPROVEMENTS – SANITARY SEWER LINES
PLAN VIEW
TEXT FOR PROPOSED IMPROVEMENTS SHALL NOT BE SMALLER THAN 100 LEROY

		WT	LC
SANITARY SEWER LINE		3	3
		3	3
MANHOLE		3	3

PROPOSED IMPROVEMENTS – SANITARY SEWER LINES
PROFILE VIEW
TEXT FOR PROPOSED IMPROVEMENTS SHALL NOT BE SMALLER THAN 100 LEROY

		WT	LC
SANITARY SEWER LINE		3	3
		3	0
		3	3
		3	0
MANHOLE		3	3
		3	0

WT	K & E PEN NO	LINE WEIGHT/WIDTH	METRIC
0	0	0.014"	0.35mm
1	1	0.020"	0.50mm
2	2	0.024"	0.60mm
3	3	0.031"	0.80mm
6	6	0.055"	1.40mm

LEGEND:
WT LINE WEIGHT
LC LINE CODE

FIGURE 3.2 (CONTINUED)
PROPOSED IMPROVEMENTS – STORM SEWER LINES
PLAN VIEW

TEXT FOR PROPOSED IMPROVEMENTS SHALL NOT BE SMALLER THAN 100 LEROY

		WT	LC
STORM SEWER LINES	24" (AND SMALLER)	3	0
	30" (AND LARGER)	3	0
MANHOLE		3	0
INLETS	"B" "B-B" "C-1" "C-2" "C-2A" "GRATE"	3	0

PROPOSED IMPROVEMENTS – STORM SEWER LINES
PROFILE VIEW

TEXT FOR PROPOSED IMPROVEMENTS SHALL NOT BE SMALLER THAN 100 LEROY



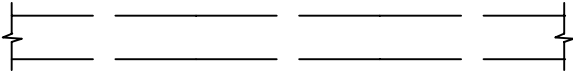
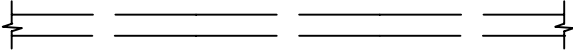
		WT	LC
STORM SEWER LINES	24" (AND SMALLER)	3	0
	30" (AND LARGER)	3	0
MANHOLE		3	0
INLETS		3	0

WT	K & E PEN NO	LINE WEIGHT/WIDTH	METRIC
0	0	0.014"	0.35mm
1	1	0.020"	0.50mm
2	2	0.024"	0.60mm
3	3	0.031"	0.80mm
6	6	0.055"	1.40mm

LEGEND:
WT LINE WEIGHT
LC LINE CODE

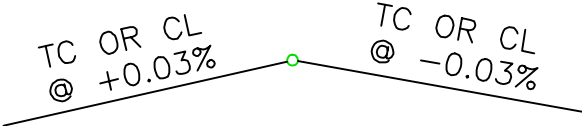
FIGURE 3.2 (CONTINUED)
 PROPOSED IMPROVEMENTS – PAVEMENTS
 PLAN VIEW

TEXT FOR PROPOSED IMPROVEMENTS SHALL NOT BE SMALLER THAN 100 LEROY

		WT	LC
FACE OF CURB		6	3
EDGE OF PAVEMENT		6	0
CONCRETE WALK		3 2 3	3 0 3
CONCRETE HEADER		3	3
TOP OF CURB OR GUTTER LINE ELEVATION	<div>TC=76.56</div> <div>G=76.06</div>	2	0

PROPOSED IMPROVEMENTS – PAVEMENTS
 PROFILE VIEW

TEXT FOR PROPOSED IMPROVEMENTS SHALL NOT BE SMALLER THAN 100 LEROY










		WT	LC
TOP OF CURB OR CENTERLINE FOR OPEN DITCH PAVING		2 3	3 0

WT	K & E PEN NO	LINE WEIGHT/WIDTH	METRIC
0	0	0.014"	0.35mm
1	1	0.020"	0.50mm
2	2	0.024"	0.60mm
3	3	0.031"	0.80mm
6	6	0.055"	1.40mm

LEGEND:

WT LINE WEIGHT
 LC LINE CODE

FIGURE 3.3
LINE CODE DEFINITIONS
ALL LENGTHS IN INCHES

LINE CODE 0	SOLID LINE 
LINE CODE 1	.8" LINE, .05" SPACE, .025" LINE, .025" SPACE, .025" LINE, .025" SPACE, .025" LINE, .05" SPACE, .8" LINE 
LINE CODE 2	.1875" LINE, .05" SPACE, .1875" LINE 
LINE CODE 3	.9" LINE, .125" SPACE, .9" LINE 
LINE CODE 4	1.25" LINE, .125" SPACE, .030" LINE, .125" SPACE, 1.25" LINE 
LINE CODE 5	.9" LINE, .1" SPACE, .1" LINE, .1" SPACE, .1" LINE, .1" SPACE, .1" LINE, .1" SPACE, .9" LINE 
LINE CODE 6	.9" LINE, .1" SPACE, .1" LINE, .1" SPACE, .1" LINE, .1" SPACE, .9" LINE 
LINE CODE 7	.9" LINE, .1" SPACE, .1" LINE, .1" SPACE, .9" LINE 
LINE CODE 8	.9" LINE, .2" SPACE, .9" LINE 

City of Houston

Design Manual

Chapter 4

PLATTING REQUIREMENTS

Chapter 4

PLATTING REQUIREMENTS

4.01 CHAPTER INCLUDES

- A. Coordination of platting requirements with the preparation of project drawings and specifications and their review and approval processing.

4.02 GENERAL PLATTING REQUIREMENTS

- A. Refer to Figures 4.1 and 4.2 for flow charts of the process by which plats and related documents are submitted, reviewed, and approved by the Department of Public Works and Engineering. There are three classes of subdivision plat: a class I plat, a class II plat and a class III plat. Class I plats and class II plats are optional and may be used in lieu of a class III plat if the subdivision plat meets the qualifications of Sec. 42-23 b and c of the platting ordinance. Class I and class II plats do not propose the creation of any new streets; nor propose the dedication of any easements for public water, wastewater collection or storm sewer lines. A class I plat goes through a ten day administrative review process within the Planning and Development Department. During that review questions may arise regarding the delivery of utilities that may be directed to Public Works and Engineering staff.
- B. Platting requirements are found in Chapter 42 of the Code of Ordinances.
- C. All class II and class III plats submitted to the Planning and Development Department will be routed to the Department of Public Works and Engineering for review.
- D. Design drawings (when required) shall be submitted to the Department of Public Works and Engineering with the name of the proposed plat clearly identified on the cover sheet.
- E. The Planning and Development Department may record plats after the Department of Public Works and Engineering approves design drawings.

4.03 DESIGN REQUIREMENTS

- A. Class III Preliminary Plat.
 - 1. The level of investigation to be performed for a class III preliminary plat is to identify major development impediments to water, wastewater collection and treatment, or storm drainage that are primarily the result of constraints external to the plat itself. Such constraints include, but are not limited to:

- a. Water Lines:
 - (1) Long dead-end water lines.
 - (2) Single feed water lines.
 - (3) Inadequate capacity or pressure to the site.
 - (4) Future plans for construction of major City facilities that will impact the site.
 - b. Wastewater Collection System:
 - (1) Inadequate right-of-way or wastewater easements.
 - (2) Limited wastewater service capacity for the area.
 - (3) Future plans for construction of major City facilities that will impact the site.
 - c. Storm Drainage System:
 - (1) Drainage outfall severely under capacity.
 - (2) Encroachment into flood-prone areas or floodway.
 - (3) Storm water detention or diversions of watershed drainage that impact the property.
 - (4) Future plans for construction of major City facilities that will impact the site.
2. Department of Public Works and Engineering will review class III preliminary plats and take one or more of the following actions:
- a. Pose no objection to the plat.
 - b. Request a meeting with the applicant to discuss design and construction requirements.
 - c. Request specific additional information, easements, or improvements to the plat or the land within the purview of the department.
 - d. Request one-line drawings be submitted prior to detailed engineering drawings and final plat submittal.
3. Approval of a preliminary plat by Department of Public Works and Engineering does not infer approval of proposed infrastructure. Review of infrastructure will take place upon submittal of one-line drawings, if required, which may occur after preliminary plat approval and must occur prior to final plat approval.

B. Class II and class III Final Plat.

1. The Department of Public Works and Engineering will review class II and class III final plats and final design drawings, easement documents, and other data. Review will be for the following items, as a minimum:

a. Compliance with standards contained in this Design Manual.

b. Adequacy of service availability for:

- (1) Water
- (2) Wastewater
- (3) Storm sewer or storm water detention.

c. Other design standards of the Department of Public Works and Engineering.

C. Comments resulting from reviews described in Paragraphs 4.03A and 4.03B will be reported to the Planning and Development Department for inclusion in CPC Form 101.

4.04 DESIGN ANALYSIS

A. For plats of land located inside the city limits, review of final design drawings and other documents required by the Department of Public Works and Engineering for final plat approval will address the following:

1. Resolution of conflicts with existing and proposed utilities.
2. Layout of water lines for maximum circulation of water. The pattern shall allow at least two sources of water to be constructed within the public right-of-way or permanent easement. Side lot easements shall meet the requirements of Chapter 5, Easement Requirements, and Chapter 7, Water Line Design Requirements.
3. Adequate capacity in water and wastewater facilities to be utilized. The City may require a current letter of utility commitment prior to approval of a plat.
4. Adequacy of drainage facilities.
5. Sizing and identification/designation of easements within the plat and required easements outside the plat boundary.
6. Recordation of required off-site easements or lift station sites, their depiction on the plat, and submittal to the City of record documents.

- B. For plats of land located outside the city limits, review of final design drawings and other documents required by the Department of Public Works and Engineering for final plat approval will address all items in Paragraph 4.04A plus the following:
1. When appropriate, a letter from the municipal utility district's president or board or from the property owner stating that all off-site easements that are not immediately obtainable (for example: those crossing fee strips, rail roads, or other areas under eminent domain) are in progress and that it is the intention of the municipal utility district or property owner to complete the acquisition of such easements. The letter will be accompanied by a certified survey plat and legal description of such easements.
 2. That separately platted tracts requiring service are or will be directly served by public utilities located in or abutting public rights-of-ways or permanent access easements with overlapping public utility easements.
 3. That necessary contracts and documents for inside the city limit and outside the city limit are approved and signed.
 4. For a plat that includes portions both inside and outside the city limits and where there will be an imminent need for utility services, a current letter of utility commitment may be required prior to approval.

END OF CHAPTER

FIGURE 4.1
CLASS III PRELIMINARY PLAT

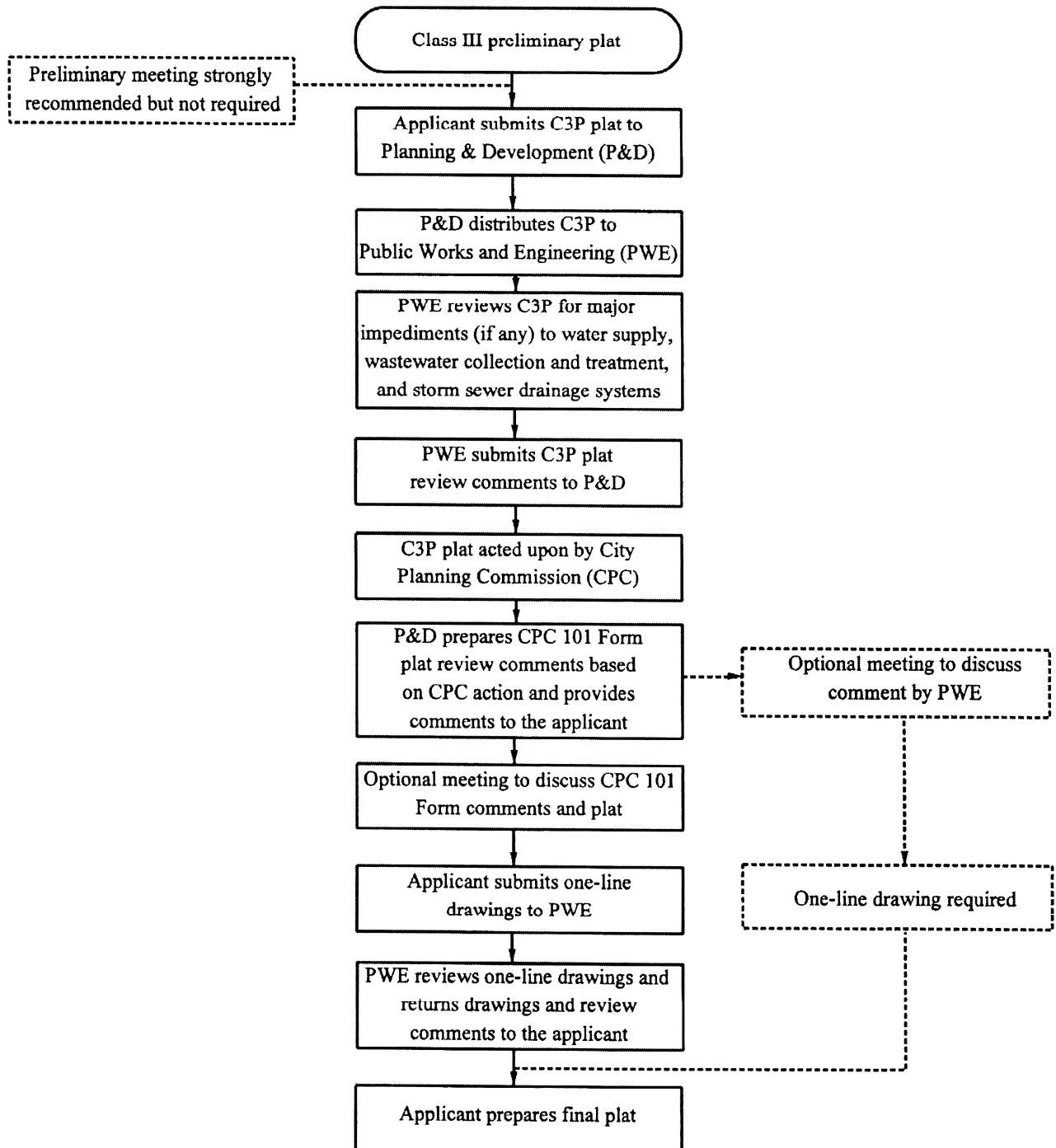
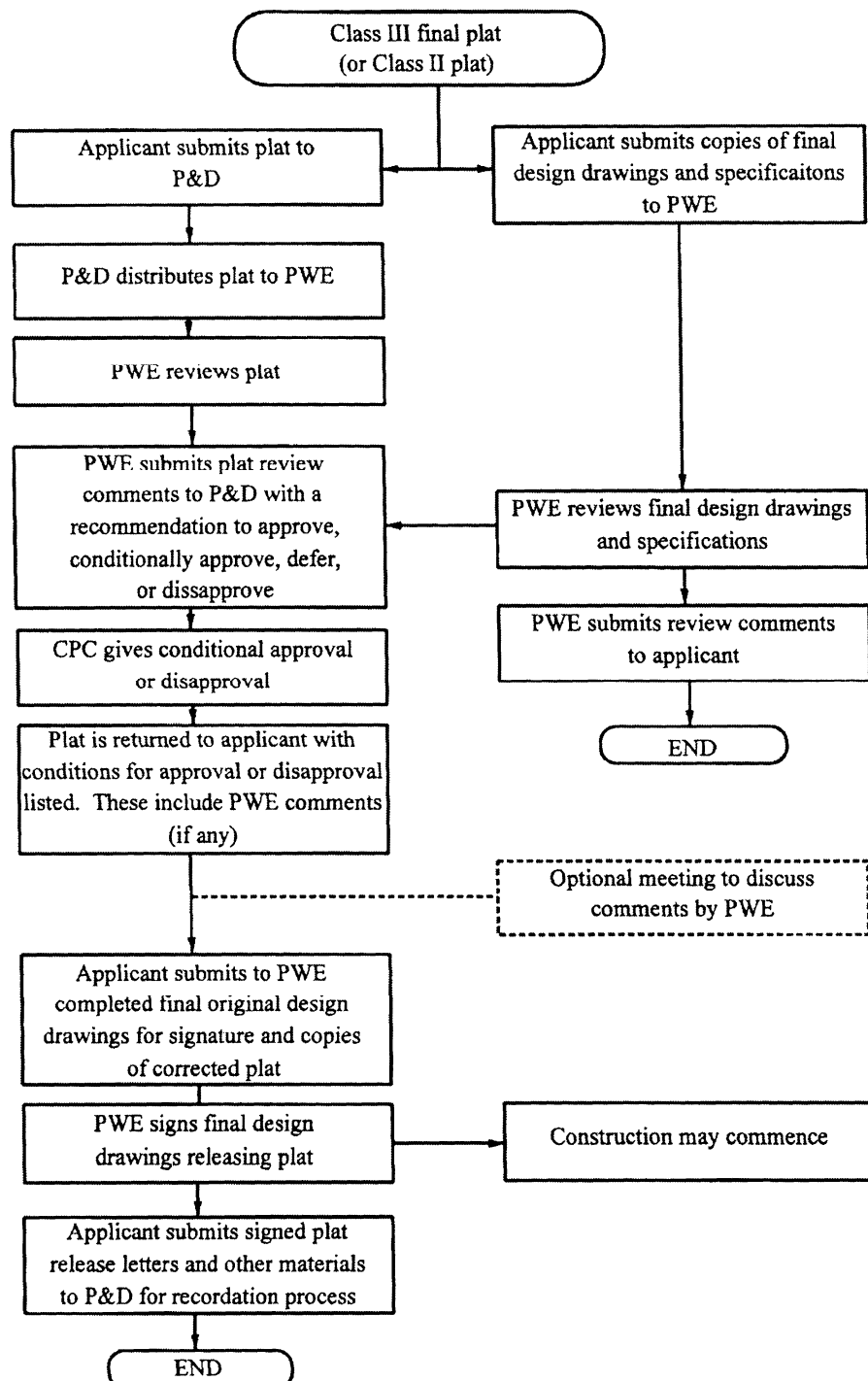


FIGURE 4.2
CLASS III FINAL PLAT (OR CLASS II PLAT)



City of Houston

Design Manual

Chapter 5

EASEMENT REQUIREMENTS

Chapter 5

EASEMENT REQUIREMENTS

5.01 CHAPTER INCLUDES

- A. Requirements for allocating and recording easements for water, wastewater, and storm drainage facilities located outside of public rights-of-way.

5.02 REFERENCES

- A. Utility Coordination Committee (UCC) for the Metropolitan Area - Typical utility location in 10-foot- and 14-foot-wide easements, back-to-back lots, and perimeter lots.

5.03 DEFINITIONS

- A. Easements - Areas set aside for installation and maintenance of utilities by public and private utility operators.

5.04 DESIGN REQUIREMENTS

- A. Where public utilities are located in, along, across or adjacent to private drives, private streets or permanent access easements in platted single family residential lot subdivisions; such drives, streets or easements shall have an overlapping public utility easement to provide access and maintenance rights. Public utility easement rights shall be superior to permanent access easement rights allowing the City ingress and egress for maintenance of utilities.
- B. Easements for electrical and gas lines must comply with requirements of the UCC and are not covered under this Design Manual.
- C. Easements are to be defined and submitted as part of the recordable plat either shown on the plat or by metes and bounds description. The process for recording the plat is described in Chapter 4, Platting Requirements.

5.05 QUALITY ASSURANCE

- A. Recordable plats and metes-and-bounds descriptions of easements must be prepared under the direction of a Professional Surveyor. The surveyor must seal, sign, and date documents prepared under his supervision.

5.06 PLAT AND EASEMENT REQUIREMENTS

A. Requirements for Platted Easements.

1. For construction inside city limits, submit a copy of the final plat accompanied by a CPC Form 101 together with the original engineering drawings for approval and signatures.
2. For construction outside city limits but within Houston's ETJ.
 - a. Where no easements are required outside the plat boundary, follow the same requirements as for plats inside city limits given in Paragraph 5.06A.1.
 - b. Where easements are to be dedicated outside the plat boundary or through property under different ownership, follow the instructions in Paragraph 5.06A.1 for plats inside city limits and the additional requirements following:
 - (1) Submit a copy of the recorded instrument creating the easement or a metes-and-bounds description and a map of the easement, along with a letter from the Municipal Utility District Board or property owner stating the intent to obtain or dedicate necessary easements. The instrument shall be recorded prior to or simultaneously with the plat.
 - (2) All off-site easements necessary to serve a proposed development must be shown on the face of the plat, or an acceptable tie between the plat and easements must be established between the two documents. Off-site easements must be recorded prior to or simultaneously with recordation of the plat.

B. Requirements for Easements Deeded to the Public or to the City. Easements required for construction of a proposed project must be approved and accepted prior to approval of final design drawings or issuance of a permit for the proposed construction.

C. Additional Requirements for Easements Deeded to the City:

1. Easements shall be either a part of the dedication on the plat of a subdivision, deeded to the City on standard forms provided by the City for that purpose, or on forms approved by the City Attorney.
2. The person seeking to deed an easement to the City shall furnish the City with a reproducible map showing the easement and its location.
3. A construction permit will be granted upon acceptance by the City of recordable instruments dedicating the easements.

5.07 DESIGN REQUIREMENTS

A. Easements for Water Lines and Appurtenances.

1. Water Lines:

- a. When outside a public street right-of-way or permanent access easement with overlapping public utility easements, easements must be dedicated and restricted for water lines only.
- b. When possible, easements should be contiguous with public rights-of-way.
- c. Provide paved access for water line easements located along back lot property lines.
- d. For water lines located outside of the street right-of-way:
 - (1) The minimum width of easement for lines 12 inches in diameter and smaller shall be 10 feet, and for lines 16 inches in diameter and larger shall be 20 feet.
 - (2) The easement shall be contiguous to the street right-of-way, or contiguous to a public utility easement that is contiguous to the street right-of-way.
- e. For water mains located less than 5 feet from right-of-way lines, the outside edge of a water line easement shall be located from the right-of-way line as follows:
 - (1) 12-inch diameter and smaller - 5 feet
 - (2) 16-inch diameter and larger - 10 feet
- f. Water lines along State rights-of-way shall be installed outside of the right-of-way in a separate contiguous easement. Width of easements shall be as provided in Paragraph 5.07.A.1.d.
- g. No backlot easements will be allowed for the installation of water lines.
- h. Commercial developments inside the City and in the ETJ requiring on-site fire hydrants must provide a minimum 20-foot water line easement for the water lines and fire hydrants.
- i. The centerline of any water line shall be no closer to a building line, building foundation or building slab than 10 feet for water lines 12 inches in diameter and smaller and no closer than 15 feet for water lines 16 inches in diameter and larger.

- j. In new developments, water lines shall be centered in water line easements.
- k. When using side lot easements, such easements shall be a minimum of 20 feet in width, located on one lot or centered between two lots. If centered between two lots, the water line may be centered within the 10 feet of one lot, or centered in the easement.

2. Fire Hydrants:

- a. Use a minimum 10-foot by 10-foot easement for fire hydrants located outside of public rights-of-way.
- b. Do not locate fire hydrants in 10-foot-wide water line or water meter easements.

3. Meters and Valves:

- a. Two-inch and smaller meters and shut-off valves (stop boxes) shall be set within public rights-of-way if possible. Otherwise, they shall be set in 5-foot by 5-foot water meter easements.
- b. The minimum size of water meter easements for three-inch through six-inch meters shall be 10-feet by 20-feet and for six-inch and larger meters shall be 15-feet by 25-feet.
- c. Water meter easements shall be located contiguous with public rights-of-way unless approved by the City. Access easements a minimum of 15 feet wide will be required when not contiguous with a public right-of-way.

B. Easements for Wastewater Lines and Appurtenances.

1. Wastewater Collection Lines:

- a. Easements adjacent to public rights-of-way, easements, or fee strips, including those owned by HCFCD, Houston Lighting & Power Company, and pipeline companies.
 - (1) Easements for sanitary sewers 10 inches or less in diameter shall have a minimum width of 15 feet or a minimum width equal to the depth of the proposed sewer, whichever is greater.
 - (2) Easements for sanitary sewers 12 inches or greater in diameter shall have minimum width of 20 feet or a minimum width equal to the depth of the proposed sewer, whichever is greater.

- b. Sanitary sewer easements or other combined easements for sanitary sewers which meet the conditions below shall have a minimum width equal to twice the sewer's diameter plus the flow line depth of the sewer from natural ground, proposed fill elevation, or 100-year Floodplain Fill Elevation, whichever is greater; but not less than 25 feet. The qualifying conditions are:
 - (1) Runs through commercial reserves or across open country (acreage);
 - (2) Serves other existing or proposed platted commercial reserves or non-platted acreage tracts; and
 - (3) Is not immediately adjacent to public rights-of-way, easements, or fee strips, including those owned by HCFCD, Houston Lighting & Power Company, and pipeline companies.
 - c. Sanitary sewers which cannot be located in the center of easements shall be located a minimum distance of half the depth from the nearest side of the easement.
 - d. Sanitary sewers or force mains, installed in easements separated from public or semi-public rights-of-way by other private or utility company easements, shall be extended along or across the private utility company easement to provide access for maintenance of the sewer or force main.
 - e. Easements described in Paragraphs 5.07B.1.a through 5.07B.1.e shall be open-ended easements in conformance with City Codes, Ordinances and Planning Requirements. Such open-ended sanitary sewer easements shall be extended if necessary and shall be fully connected at both ends to public facilities including existing or proposed:
 - (1) Public road rights-of-way
 - (2) Wastewater treatment plant sites
 - (3) Wastewater pump station sites
 - (4) Public utility easement of adequate size for maintenance access.
2. Force Mains:
- a. Force mains of all sizes shall have a minimum easement width of 20 feet for single lines which are not located adjacent to public or semi-public rights-of-way.
 - b. Force mains located in easements adjacent to public or semi-public rights-of-way shall have a minimum easement width of 10 feet subject to location and depth of the force main.
3. Service Leads: The minimum easement for building service leads is 6 feet.

C. Storm Drainage Lines and Appurtenances.

1. Storm Sewer Lines:

- a. To the extent practical, storm sewers shall be placed in public road rights-of-way or permanent access easements with overlapping public utility easements in accordance with Chapter 6, Utility Locations.
- b. Storm sewers shall have a minimum 20-foot-wide easement. In the event of extreme depth or large sewers, additional width may be required to allow for proper maintenance operations.
 - (1) Maintenance operations require an easement width equal to the storm sewer width plus the depth rounded up to the nearest multiple of 5-feet.
- c. Storm Sewers shall be centered within the limits of the easement.

2. Storm Water Detention Basins:

- a. Easements for storm water detention basins shall be dedicated by plat or by separate instrument filed in conjunction with plat approval. Such easements shall be dedicated to the developer, owner, or water district.
- b. Such easements shall have a minimum 20-foot width surrounding the perimeter of the detention basin as measured from top of bank unless adjacent to a street right-of-way.

D. Combined Storm and Sanitary Sewer Easements.

- 1. Combined storm and sanitary sewer easement widths shall be as specified in 5.07C.1.b for storm sewer lines. The centerlines of sanitary sewer mains, trunks, or force mains shall be located in at least half the width of the easements defined in Paragraph 5.07B.1, but not less than 10 feet from the edge of the easement.
- 2. The centerline of sanitary sewers on the outside of combined storm and sanitary sewer easements adjacent to public or semi-public rights-of-way, shall be located in at least half the width of the easement defined in Paragraph 5.07B.1.d, but not less than 10 feet from the outside edge of the easement.

END OF CHAPTER

City of Houston

Design Manual

Chapter 6

UTILITY LOCATIONS

Chapter 6

UTILITY LOCATIONS**6.01 CHAPTER INCLUDES**

- A. Location of utilities in rights-of-way and easements.

6.02 REFERENCES

- A. Typical utility location in 10-foot-wide and 14-foot-wide easements in back-to-back lots and perimeter lots as detailed in the most current drawing prepared by the UCC.

6.03 DEFINITIONS

- A. Easements - Areas set aside for installation and maintenance of utilities by public and private utility companies.
- B. Water Lines - Closed conduits designed to distribute potable water for human consumption and to provide fire protection. Line size and fire protection accessory locations are dependent on distance from primary source and quantity demand.
- C. Wastewater Sewer Lines - Closed conduits designed to collect and transport wastewater from residential, commercial, and industrial sites to plants for treatment prior to discharge into open conduits. Wastewater lines may be designed as gravity (non-pressure) flow lines or force (pressure) mains. Gravity flow lines usually fall into three categories in ascending size from service line to lateral line to main line. Service lines (source of wastewater) may discharge into a lateral line or main line.
- D. Storm Sewer Lines - Closed gravity (non-pressure) conduits designed to collect and transport storm water from inlet locations to an open conduit outfall, ditch, creek, stream, bayou, river, holding pond, or bay. Inlets are surface mounted basins designed to collect and funnel storm water to the collection system. Storm sewers from the inlets to the collection system are usually defined as inlet leads.

6.04 DESIGN REQUIREMENTS

- A. Whenever practical, locate storm sewer, wastewater collection lines, water mains, and appurtenances within public rights-of-way in the manner described by this Chapter.
- B. Research and resolve known conflicts of proposed utilities with existing utilities.

- C. Locate back lot utilities in compliance with UCC recommendations.
- D. Identify water lines as to size, location, depth, and material on final design drawings. Also identify water line accessories, such as bends, valves, fittings, and fire hydrants as to type on the drawings.
- E. Identify wastewater sewer lines as to the size, location, depth, grade for gravity service, and material on final design drawings. Also identify wastewater sewer line accessories, such as manholes, cleanouts, and fittings, as to size and material on the drawings.
- F. Identify storm sewer lines as to size, location, depth, grade, and material on final design drawings. Also identify storm sewer line accessories, such as manholes, headwalls, and inlets as to size and material on the drawings.

6.05 SUBMITTALS

- A. Easements and rights-of-way are clearly identified for location and width on recorded plats. Off-site easements and rights-of-way shall be described by metes-and-bounds descriptions with accompanying drawings to clearly identify location and width. Final design drawings shall identify easements and rights-of-way as shown on recorded plats or by recorded metes-and-bounds descriptions.
- B. Water lines shall be identified on final design drawings with specific graphics and dimensioned from edge of easements and rights-of-way. The primary source of potable water shall be identified.
- C. Wastewater sewer lines shall be identified on final design drawings with specific graphics and dimensioned from edge of easements and rights-of-way. The outfall or discharge location shall be identified.
- D. Storm sewer lines shall be identified on final design drawings with specific graphics and dimensioned from edge of easements and rights-of-way. The outfall or discharge location shall be identified.
- E. Where the criteria for location of the utility is the clear distance between the outside edge of the conduit to easement or right-of-way line, show this controlling dimension.

6.06 QUALITY ASSURANCE

- A. Recorded metes-and-bounds descriptions and plats shall be prepared by or under the supervision of a Professional Surveyor. Recordable instruments shall be sealed, dated, and signed by the Professional Surveyor responsible for the preparation.

- B. Prepare calculations and final design drawings under the supervision of a Professional Engineer trained and licensed under the disciplines required by the scope of the project. The final construction drawings must be sealed, signed, and dated by the Professional Engineer responsible for the development of the drawings.

6.07 DESIGN ANALYSIS

- A. Back Lot Utilities: Identify type of electrical service and select the appropriate width of the easement. For mixed overhead and underground service select the 14-foot-wide easement to provide versatility.
- B. Water Lines.
 - 1. Water lines may be located within a public right-of-way, within a permanent access easement with overlapping public utility easements, within a dedicated easement adjacent to and contiguous with the right-of-way, or within separate dedicated water line easements, to meet the requirements of this manual. The location of the main shall be as specified in Chapter 7, Water Line Design Requirements.
 - 2. Water lines shall not be located in combination easements without approval of the City. Water line easements shall not be combined with wastewater sewer easements.
- C. Wastewater Sewer Lines.
 - 1. Wastewater sewer lines shall be located in a public right-of-way, within a permanent access easement with overlapping public utility easements or within a dedicated easement adjacent to the public right-of-way. Side lot easements may be used when required. Backlot easements shall not be utilized except in cases of pre-existing conditions and with approval of the City.
 - 2. New developments will be required to comply with the requirement to locate wastewater sewer lines in compliance with Paragraph 6.07C.1.
 - 3. Wastewater sewer trunk or collector mains shall not be located in side lot easements without approval of the City.
 - 4. Wastewater sewer trunk or collector mains are usually located within the right-of-way between the property line and the back of curb or in a dedicated easement adjacent and contiguous with the right-of-way on the opposite side of the right-of-way from the water main.

D. Storm Water Lines.

1. Storm water lines shall be located within public rights-of-way, permanent access easements with overlapping public utility easements or approved easements. Approval of the location for storm water lines should be obtained from the City prior to plan preparation.
2. Storm water lines are usually located within the parkway on the opposite side of the right-of-way from the sanitary sewer. Do not locate storm water trunk lines under the pavement section. For boulevards with esplanades, the storm sewer may be located within the esplanade. Coordinate with water line location and future pavement widening.

6.08 OPEN-CUT CONSTRUCTION IN STREET PAVEMENT

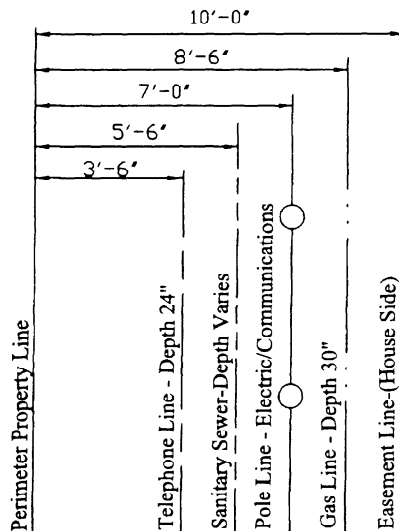
- A. Construction documents shall require that one lane of traffic be open at all times with a flagman at both ends of the construction unless otherwise provided on an approved traffic control plan.
- B. For open-cut construction in street pavement, the drawings shall call for steel plate covers to be placed over open-cut sections whenever the contractor is not working within the open-cut area so that traffic will have full use of the roadway.

6.09 BACK LOT UTILITY LOCATIONS

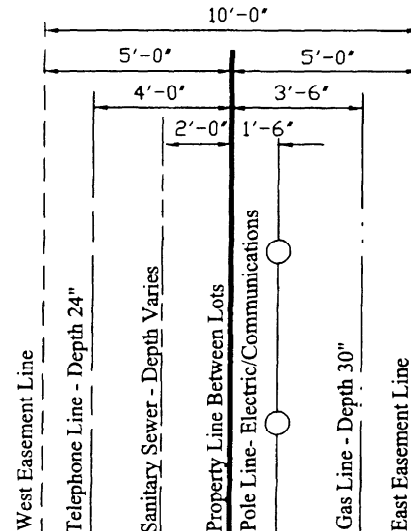
- A. The basic utility locations for a 10-foot-wide back lot easement are as shown in Figure 6.1, Typical Utility Location in 10-foot-wide Residential Easement, prepared by the UCC. A portion of the drawing is reproduced here for reference. The basic utility locations for 14-foot-wide back lot easement is as presented in the May 15, 1996, UCC Memo of Understanding, and is reproduced here for reference as Figure 6.1, Typical Utility Locations in 10-foot-wide Residential Easement, and 6.2, Typical Utility Locations in 14-foot-wide Residential Backlot Easement.

END OF CHAPTER

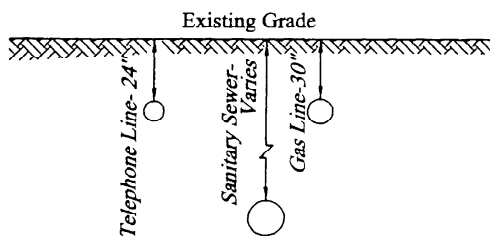
FIGURE 6.1
TYPICAL UTILITY LOCATIONS IN 10-FOOT-WIDE
RESIDENTIAL EASEMENT



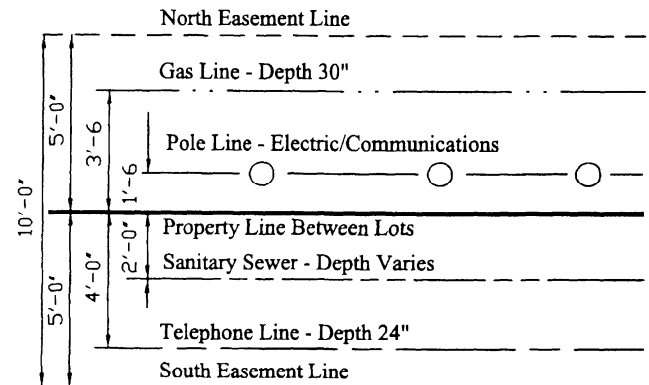
PERIMETER EASEMENT



BACK-TO-BACK EASEMENT



TYPICAL INSTALLATION
DEPTHS

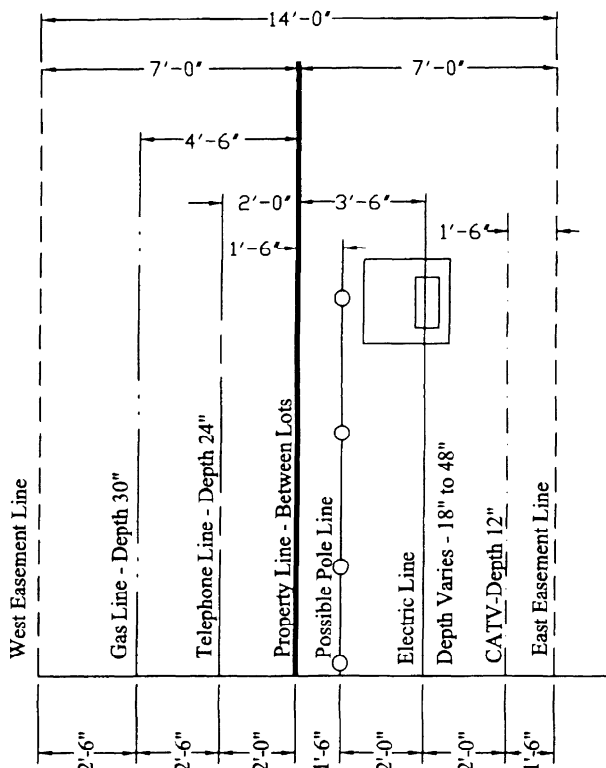


BACK TO BACK EASEMENT

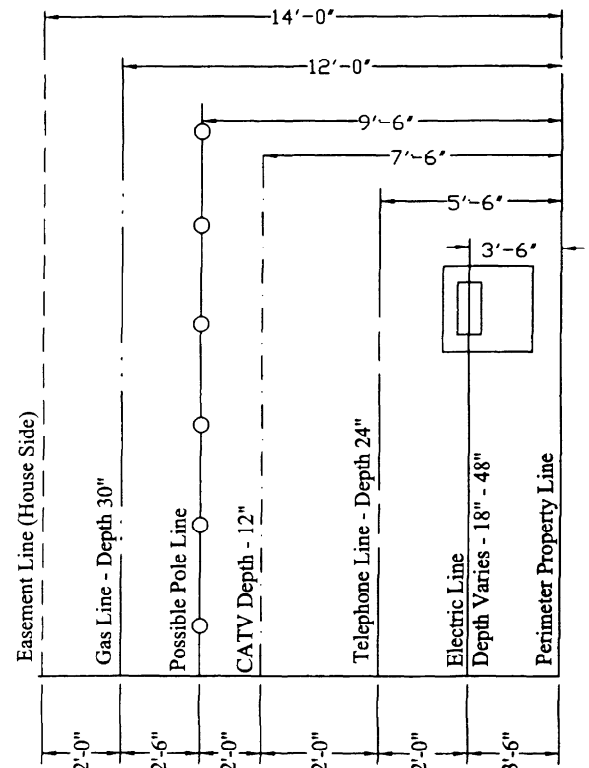
NOTES:

- (1) Utilities are normally installed as shown but depth may vary due to fill or cut by others.
- (2) Maintain minimum 4" clearance between utility lines extending from easement to house/building.
- (3) Flexible base shall be 8" minimum hot mix asphaltic concrete (hmac).

FIGURE 6.2
TYPICAL UTILITY LOCATIONS IN 14-FOOT-WIDE
RESIDENTIAL BACKLOT EASEMENT
(NO BACKLOT SEWER)



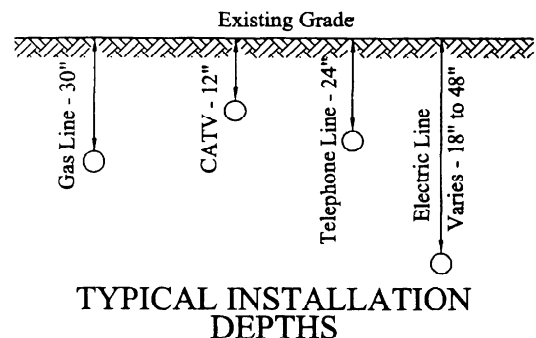
BACK-TO-BACK EASEMENT



PERIMETER EASEMENT

NOTES:

- (1) Utilities are normally installed as shown, but depth may vary due to fill or cut by others.
- (2) Maintain minimum 4" clearance between all utility lines extending from easement to house/building.
- (3) Always exercise extreme caution when digging in utility easements and on or across customer's property, because service lines extend from easement to house.
- (4) 10' Utility Easements may be granted if approved by the Utilities and City Council.



TYPICAL INSTALLATION
DEPTHS

City of Houston

Design Manual

Chapter 7

WATER LINE DESIGN REQUIREMENTS

Chapter 7

WATER LINE DESIGN REQUIREMENTS

7.01 CHAPTER INCLUDES

- A. Criteria for the design of water lines.

7.02 REFERENCES

- A. American Water Works Association (AWWA).
- B. National Sanitation Foundation (NSF).
- C. Refer to the list of references in Chapter 1, General Requirements.

7.03 DESIGN REQUIREMENTS

- A. Obtain approval from the Office of the City Engineer (OCE) Division for exceptions or deviations from these requirements. Exceptions or deviations may be granted on a project-by-project basis.
- B. Lines.
 - 1. Locate water lines within street rights-of-way, permanent access easements with overlapping public utility easements, easements adjacent to street rights-of-way, or recorded water line easements:
 - a. Pipe with 2-inch diameter is allowed only in rehabilitation projects where tie-ins to existing 2-inch lines are necessary.
 - b. Pipe with 4-inch diameter may be used on dead-end lines within cul-de-sacs supplying a maximum of 16 lots.
 - c. Pipe with 6-inch diameter may be used if the line is less than 1000 feet in length and interconnected between 2 lines which are 8-inch diameter or larger. Only one fire hydrant or flushing valve is allowed on any length of 6-inch diameter line.
 - d. Use minimum 8-inch diameter pipe for lines over 1000 feet long or when 2 or more fire hydrants or flushing valves are required.
 - e. Pipes 12-inch diameter and larger shall be used as determined by the Professional Engineer and approved by OCE Division.

- f. Dead-end lines:
 - (1) Dead-end lines within public right-of-way.
 - (a) On permanent dead ends, other than cul-de-sacs, the line shall be 6-inch diameter or larger, and shall not exceed more than 500 feet in length from the closest interconnection main line and shall terminate with a fire hydrant or flushing valve.
 - (b) In permanent dead-end situations within cul-de-sacs, reduce pipe sizes successively. Carry 6-inch diameter pipe to the last hydrant, then use 4-inch diameter pipe to the line's end. Place last service as near as possible to the end and install standard 2-inch blowoff valve and box at the end of the 4-inch diameter line. Maximum length of this reduced line size configuration should not exceed 800 feet.
 - (2) Dead-end lines with one on-site fire hydrant or flushing valve.
 - (a) Pipe with 6-inch diameter may be used for lengths less than 200 feet, provided domestic service is taken from end of line.
 - (b) Pipe with 8-inch diameter may be used for lengths greater than 200 feet but less than 500 feet, provided domestic service is taken from end of line.
- g. Install water lines that are located in side lot easements inside a continuous steel casing pipe. Extend the casing uninterrupted from building line to building line, except the length of the line shall not exceed 150 feet. No horizontal or vertical deflections or connections are allowed. Construct encased water line of restrained joint bell and spigot pipe to prevent lateral movement. Provide casing spacers and end seals in accordance with Standard Specifications.

C. Location and Depth of Cover.

Table 7.1
WATER LINE LOCATION WITHIN A STREET RIGHT-OF-WAY

RIGHT-OF-WAY WIDTH & EXISTING OR ANTICIPATED CURB FACE TO FACE PAVING WIDTH		8" & SMALLER ^{(1) (2)}	12" THRU 20" ^{(1) (2)}	24" & LARGER ^{(1) (2)}
100-FOOT ROW (ALL STREETS):		8 feet	7 feet	10 feet
80-FOOT ROW (ALL STREETS):		7 feet	6 feet	10 feet
60-FOOT ROW:				10 feet
MAJOR THOROUGHFARE:	44 feet	5 feet	5 feet	10 feet
COMMERCIAL, SCHOOL, PARK:	40 feet	7 feet	6 feet	10 feet
RESIDENTIAL:	27 feet	12 feet ⁽³⁾	12 feet ⁽³⁾	12 feet ⁽³⁾
50-FOOT ROW:				
ALL STREETS:	35 feet	5 feet	5 feet	10 feet
ALL STREETS:	27 feet	7 feet	7 feet	10 feet

(1) *The number listed below is the maximum allowable distance from the right-of-way to the centerline of the proposed water line.*

(2) *The minimum distance from the right-of-way to the centerline of the proposed water line shall be 5 feet without a water line easement adjacent to the rights-of-way (see easements for requirements less than 5 feet).*

(3) *Investigate the possibility of a future 35-foot face-to-face curb-and-gutter section to replace existing streets with roadside ditches.*

1. Boulevard streets: When necessary, water lines may be located within the esplanade. The lines should be located as near the centerline of street right-of-way as possible to avoid conflict with future pavement widening.
2. Locations within an easement: Locate water lines 16-inch diameter and smaller in the center of a 10-foot minimum width dedicated water line easement and water lines larger than 16-inch diameter in the center of a 20-foot minimum width dedicated water line easement. Do not locate lines 16-inch diameter and larger in side lot easements. For location within side lot easements, see Chapter 5, Easement Requirements. Obtain approval from OCE Division for lines to be located in wider or multi-use easements.
3. When a water line is placed parallel to another utility line, other than a sanitary sewer, and is located above the other utility, water lines 16-inch diameter and smaller shall have a minimum of 4 feet horizontal clearance from outside wall of the water line to outside wall of the other utility.

4. When a water line is placed parallel to another utility line, other than a sanitary sewer, and is located below the other utility, the water line 16-inch diameter and smaller shall have a minimum of 5 feet horizontal clearance from outside wall of the water line to outside wall of the other utility.
5. Depth of cover.
 - a. Provide the following minimum depths of cover from the top of curb for curb-and-gutter streets or from mean elevation of the nearby ditch bottom and the nearby right-of-way for open-ditch section:

Table 7.2
DEPTH OF COVER FOR WATER LINES

SIZE OF LINE	DEPTH OF COVER		ABSOLUTE MINIMUM
	TOP-OF-CURB	OPEN-DITCH SECTION	
12-INCH & SMALLER	4 feet	5 feet	3 feet
16-INCH & 20-INCH	5 feet	6 feet	3 feet
24-INCH & LARGER	6 feet	8 feet	4 feet

- b. Whenever possible, changes in grade or alignment to clear utilities or underground features should be accomplished by deflecting the pipe joints. The use of regular bends for any change in grade will not be allowed without prior approval from OCE Division for variance.
 - c. Use restrained joint pipe for lines 16-inch diameter and smaller with less than 4 feet or more than 8 feet of cover. The following direct bury alternates may be used:
 - (1) Ductile iron pipe pressure class 250 with approved restrained joints.
 - (2) PVC pipe with ductile iron integral restrained joints, epoxy lined and coated fittings. Use 250 psi AWWA C900 DR 14 for vertical offsets.
 - (3) Use only ductile iron and PVC products listed on OCE Division approved products list.
- D. Appurtenances.
 1. Do not place appurtenances under pavement. Obtain approval from OCE Division for variances.

2. Valves.

- a. Spacing - set at maximum distances along the line as follows:
 - (1) 4-inch through 12-inch diameter - 1000 feet.
 - (2) 16-inch and 20-inch diameter - 2000 feet.
 - (3) 24-inch diameter and larger - obtain OCE Division approval.
 - (4) Total number of valves at any water line intersection shall equal total number of lines leading out from the intersection point minus one, three valves for a cross, and two valves for a tee.
- b. Location:
 - (1) Normally, locate valves at street intersections along the street right-of-way lines projected across the water line. Tapping sleeves and valves are excluded from this requirement.
 - (2) Isolate fire hydrants and flushing valves from the water line with a valve located in the fire hydrant or flushing valve branch. This valve shall not be located in the slope or flowline of roadside ditches.
 - (3) Intermediate valves, not located on the projection of the right-of-way line, shall be located on lot lines or 5 feet from fire hydrants but not set in driveways.
 - (4) Locate valves a minimum of 9 feet horizontally from sanitary sewer crossings.
 - (5) Valves located near reducers shall be located on the smaller diameter pipe.
- c. Valve Type (Unless otherwise specified):
 - (1) 20-inch and smaller - Gate valves.
 - (2) 24-inch and larger - Butterfly valves.

3. Fire Hydrants and Flushing Valves.

- a. Spacing:
 - (1) Single-family residential development - 500-foot maximum spacing.
 - (2) All other developments - 350-foot maximum spacing.
- b. Location in or along street right-of-way:
 - (1) Locate fire hydrants primarily at street intersections.
 - (2) Locate fire hydrants at PCS of the intersection curb radius, 3 feet behind curb or projected future curb.
 - (3) On streets with roadside ditches, set the fire hydrants within 5 feet of rights-of-way lines.
 - (4) Set intermediate fire hydrants on lot lines, as extended to pavement, when located between right-of-way intersections. These locations may be adjusted 5 feet either way to avoid

driveways or obstructions. In either case, do not locate fire hydrants closer than 3 feet from curbed driveways or 5 feet from non-curbed driveways.

- (5) Fire hydrants may be set in the esplanade section of City streets when locations at back of curbs are not feasible. In such cases, the preferred location is 7 feet behind back of curb to provide access for parkway mower. In no instance shall the fire hydrant be closer than 3 feet from back of esplanade curb or closer than 10 feet from esplanade nose.

- c. Location of fire hydrants or flushing valves outside street rights-of-way:
 - (1) The City Fire Marshall will establish and approve the location of fire hydrants and flushing valves in apartment complexes, platted private street developments, and other multi-family developments within the City and within the City's ETJ.
 - (2) Locate fire hydrants and flushing valves in protected, easily-accessible areas behind curb lines.
 - (3) For fire hydrants or flushing valves which are located adjacent to water lines constructed in 10-foot wide water line easements, the fire hydrant or flushing valve shall be centered in a minimum 10-foot by 10-foot separate easement.
 - (4) For commercial developments inside the City and ETJ, provide isolation valves at each end of fire loops requiring on-site fire hydrants.
- d. Fire hydrants shall be designed to have a 4-foot bury where possible. As a normal policy bends or offsets in fire hydrant branch will not be allowed. Bends may be used to maintain a 4-foot bury or to maintain 3-foot back of curb with prior approval from OCE Division.

4. Fittings.

- a. Normally use "all bell" (designated AB) for fittings. Properly designed thrust blocks shall be provided for each AB fitting for diameters 12-inch and smaller.
- b. Provide fittings with approved restraint joints for diameters 16-inch and larger. Show length of restrained joints on drawings in the profile view.
- c. Use plugs with retention clamps and carrying the designation "plug and clamp." Do not use thrust blocks at end of plug. See Paragraph 7.03H.2 for additional requirements.
- d. Connections to existing water lines 4-inch diameter and larger, shall be made with tapping sleeve, and valve with valve box.

E. Water Meter Service.

1. Water meter service for lines in or along street rights-of-way. Locate in areas with easy access and with protection from traffic and adjacent to rights-of-way whenever possible. Do not locate meters in areas enclosed by fences.
 - a. Meters 2 inches and smaller: Locate in rights-of-way, water line easements, or in a minimum 5-foot by 5-foot separate water meter easement. Provide concrete meter boxes for meters located under sidewalks.
 - b. Meters 3 inches to 6 inches: Locate in minimum 10-foot by 20-foot separate water meter easement.
 - c. Meters 8 inches and larger: Locate in minimum 15-foot by 25-foot separate water meter easement.
 - d. Separate tap and service lead shall be designed for each meter. Meter, line size, and appurtenances shall conform to the latest edition of the Uniform Plumbing Code.
2. Refer to Submittals Paragraph, and Drawings Paragraph of this Chapter, for approval and drawing requirements for meter service leads 4-inch diameter and larger, and metered sprinkler connections.
3. For proposed apartments or townhomes in private street developments, provide one master meter sized for the entire development. Exceptions may be granted by OCE Division. If an exception is approved, do not interconnect multiple meters.
4. For commercial developments with on-site water mains in easements for fire protection, provide fire service meters adjacent to the public right-of-way. If a dual feed is desired, both feeds shall be metered. An above-ground, reduced pressure, zone-type backflow preventer shall be installed on the water line downstream from the meters.
5. Do not install stubouts for future water services.
6. Show meter sizes for 1-1/2 inch or larger water meters.

F. Water Line Crossings.

1. Public and private utility crossings other than sanitary sewer: Where a water line crosses another utility other than a sanitary sewer, a minimum of 12 inches of clearance must be maintained between the outside wall of the water line and the outside wall of the utility.

2. Stream, ditch, or aerial crossings.
 - a. Elevated crossings, general:
 - (1) Elevated crossings are preferred to underground crossings.
 - (2) Design elevated crossings with the elevation of the bottom of the water line above the low chord of the nearest adjacent bridge or a minimum 1-1/2 feet above the 100-Year Floodplain Elevation, whichever is greater.
 - (3) Water lines shall be steel pipe and shall extend a minimum of 15 feet beyond the last bend or to the right-of-way line of the crossing, whichever is greater.
 - b. Elevated crossings on existing structures:
 - (1) 12-inch diameter and smaller water lines supported on existing or proposed bridges, must meet the following criteria. Coordinate location of lines, in advance, with OCE Division.
 - (a) Have adequate structural capacity.
 - (b) Have sufficient clearance above bent cap elevation for installation under the bridge.
 - c. Elevated crossings on separate structures:
 - (1) Use a separate elevated supporting structure for 16-inch diameter and larger water lines unless otherwise approved by OCE Division. Locate separate structures a minimum of 10 feet clear from other existing or proposed structures.
 - (2) Support the line on columns spaced to accommodate structural capacity of the pipeline considering deflection and loading.
 - (3) Base column support design on soil capacity, spacing, loading, and structural requirements.
 - (4) Provide sufficient span length to accommodate the cross section of future widening of the stream or ditch, if available.
 - (5) Provide appropriately sized air release valves at the highest point of the water line.
 - (6) Provide pedestrian pipe guards on elevated crossings.
 - d. Underground Crossings:
 - (1) Provide a minimum 5-foot clearance above top of pipe to the ultimate flow line of the ditch.
 - (2) Provide sufficient length to exceed the ultimate future development of the stream or ditch.
 - (3) Water lines shall be restrained joint pipe and shall extend a minimum of 15 feet beyond the last bend or to the right-of-way line of the crossing, whichever is greater.
3. TxDOT and County Road Crossings.

- a. Extend carrier pipe from right-of-way to right-of-way.
 - b. Use restrained joint pipe in steel casing under existing and future roadway from a point 5 feet outside of the service road or outside of pavement toward the right-of-way, to a similar point on the other side of the highway across the right-of-way. For highway or roadway crossings with open-ditch sections, extend casing from right-of-way to right-of-way.
 - c. Where additional right-of-way has been acquired, or is being acquired, for future widening, the casing shall extend to within 10 feet of each right-of-way line.
4. Railroad Crossings.
 - a. For mainline and spurline railroad crossings, the water line material shall conform to Railroad requirements and have restrained joint pipe within a steel casing which extends from right-of-way to right-of-way, but no less than 30 feet from the center line of the outside rails.
 - b. For crossings on rights-of-way not owned by a railroad, extend casing 20 feet either side from the centerline of the outside rails.
5. Additional Requirements.
 - a. Use electrically isolated flange joints for transitions between two dissimilar metallic pipes. Electrically isolate water lines from casing pipe and supports.
 - b. The carrier pipeline shall extend a minimum of 1 foot beyond the end of the casing to allow flanged joints to be constructed.
6. Oil and Gas Pipeline Crossings: Do not use metallic pipe when crossing oil or gas transmission lines unless a properly designed cathodic system is implemented with OCE Division approval. Other pipe may be used, regardless of depth, subject to approval by OCE Division. Maintain a minimum 2-foot vertical separation between the pipeline and water line.
7. On-site Fire Loops within Commercial Developments.
 - a. For commercial developments inside the City and in the ETJ requesting on-site water mains, comply with the following requirements to allow maintenance and future repair operations:
 - (1) Do not allow placement of structures, paved parking or equipment pads over the easement.

- (2) Provide 20-foot-wide longitudinal pavement joints along easement lines where the water line is located under driveway or street pavement.
- G. Auger Construction: Use the following general criteria for establishing auger sections:
1. Improved streets - Use auger construction to cross a street regardless of surface. Auger length shall be computed as roadway width at proposed auger location plus 5 feet to either side of roadway.
 2. Driveways - Use auger construction to cross active driveways. Compute auger length as driveways width plus 1 foot to either side. Where proposed lines are in close vicinity and parallel to culvert pipes along roadside ditch streets, the length of auger shall be the same as the length of existing culvert plus 1 foot either end.
 3. Trees - Use auger construction to cross within 10 feet of trees 6 inches and larger in diameter. Use a minimum auger length to clear the tree canopy.
 4. See the Drawings Chapter of this section for auger construction drawing standards.
- H. Circulation and Flushing for Water Quality: The layout of the water distribution system shall provide maximum circulation of water to prevent future problems of odor, taste, or color due to stagnant water.
1. Provide a source of fresh water at each end or at multiple points of a subdivision. Provide ways to create circulation and place valves and fire hydrants to allow simple flushing of lines.
 2. Where stubs are provided for future extensions, isolate the stubs with a valve and do not allow service connections to stubs until extended. Provide the following length of restrained pipe upstream of the plug.

Table 7.3
LENGTH OF RESTRAINED PIPE AT DEAD ENDS

SIZE OF LINE	DEPTH OF COVER ⁽¹⁾		MINIMUM RESTRAINED PIPE LENGTH
	TOP-OF-CURB	OPEN-DITCH SECTION	
12-INCH & SMALLER	4 feet	5 feet	88 feet
16-INCH & 20-INCH	5 feet	6 feet	140 feet
24-INCH & LARGER	(2)	(2)	(2)

(1) Provide specific design for pipe with less than the specified minimum cover.

(2) Provide specific design for pipe 24-inches and larger.

- I. Interconnections.
1. For interconnections between utility districts outside the City, written approval must be given by the TCEQ.

2. A written agreement between the districts must be approved by the City and recorded in the county records and furnished to the City.
3. Set meter at the point of connection in a separate easement sized to conform to requirements of Chapter 5. Meter to conform to requirements given in the City of Houston Standard Specifications and Standard Details.
4. Requirements for installation of a meter may be waived by the City, if provisions are made in the agreement between the districts. In this event, a separate easement, sized to conform to requirements of Chapter 5, and valves shall be provided for future meter installation.
5. Agreement between districts shall provide for annexation of the meter site by one district and shall require the installation of a meter. The installation and full cost shall be provided by the district not annexing the meter site.
6. For connection to City water lines serving districts or areas outside the City, written approval must be obtained from the TCEQ. No customer may take pump suction directly from City water lines. If a customer has his own well or other supply, an appropriate backflow preventer must be installed to prevent water from flowing into City water lines. Conform to the procedures for connection to City water lines in effect at the time of connection. Consult with the Public Utilities Division for current requirements.

J. Proposed Water Lines Constructed near Sanitary Sewers and Force Mains.

1. Proposed Water Lines Parallel to Sanitary Sewers and Force Mains: Locate water lines a minimum of 9 feet horizontally apart, measured from outside wall to outside wall, when parallel to sanitary sewers and 4 feet horizontally apart, measured from outside wall to outside wall, when parallel to force mains. Use the following procedure when stated separation cannot be achieved:
 - a. When a proposed water line is to parallel an existing sanitary sewer force main or gravity sanitary sewer and the 9-foot minimum separation distance cannot be maintained, the existing sanitary sewer shall be replaced with lined ductile iron pipe or PVC pipe meeting ASTM specifications, having a minimum working pressure rating of 150 psi or greater and equipped with pressure-type joints.
 - b. The water lines, sanitary sewers, or force mains, shall be separated by a minimum vertical distance of 2 feet, and a minimum horizontal distance of 4 feet, measured between the nearest outside walls of the pipes. In all cases, locate 20-inch diameter and smaller water lines above gravity sewer lines.
2. Proposed Water Lines Crossing Sanitary Sewers and Force Mains.
 - a. No protection is required if the sanitary sewer is 9 feet below the water line.
 - b. Use the protective requirements given in Table 7.4, Protection Requirements at Water Line - Sanitary Sewer Crossings, and Table 7.5, Protection Requirements at Water Line - Force Main Crossings, for sanitary sewer crossings not 9 feet below the water line.

Table 7.4
PROTECTION REQUIREMENTS AT
WATER LINE - SANITARY SEWER CROSSINGS

PRIMARY CONDITION	PROPOSED WATER EXISTING SANITARY				PROPOSED WATER PROPOSED SANITARY OR EXISTING WATER PROPOSED SANITARY			
SECONDARY CONDITIONS	WATER OVER SANITARY		WATER UNDER SANITARY		WATER OVER SANITARY		WATER UNDER SANITARY	
IF THE CLEARANCE IS	Less than 2'	Greater than or equal to 2' but less than 9'	Less than 2'	Greater than or equal to 2' but less than 9'	Less than 2'	Greater than or equal to 2' but less than 9'	Less than 2'	Greater than or equal to 2' but less than 9'
*Protection Requirement	1,2,3	2	6	4	1,3,5	2	1,3,5	5

*** PROTECTION REQUIREMENTS FOR SANITARY SEWER CROSSINGS**

(Unless Variance is Granted by the TCEQ)

(All clearances shall be measured from outside wall to outside wall)

1. Place one full section of approved restrained joint water line centered at sanitary sewer. Not applicable for existing water.
2. If no evidence of sanitary sewer leakage, place one full section of water line centered over sanitary sewer; if there is evidence of leakage, use note 4 below.
3. One foot minimum clearance.
4. Auger 9 feet minimum each side of sanitary sewer. Place one full section of water line, centered under sanitary sewer. Fill augered hole with bentonite/clay mixture. If sewer line is leaking, sewer line shall be replaced with 150 psi lined ductile iron or PVC pipe with appropriate adapters on all portions of the sanitary sewer within 9 feet of the water line. Provide restrained joints for both water and sanitary sewer lines at each end of proposed pipe section. Water line must pass a pressure and leakage test as specified in City's Standard Specifications. Sewer line shall pass an infiltration, ex-filtration low pressure air test or leakage test as specified in TCEQ Chapter 317-2 Design Criteria for Sewage Systems.
5. Place minimum one full section of sanitary sewer, 150 psi lined ductile iron or PVC pipe centered at the water line and provide restrained joints for both water and sanitary sewer lines at each end of proposed pipe section. Use cement-stabilized sand backfill for all portions of the sanitary sewer within 9 feet of the water line, as measured perpendicularly from any point on the water line to the sanitary sewer (minimum 2.5 sacks cement per cubic yard of sand). The cement-stabilized sand bedding shall start at a point 6 inches below the bottom of sanitary sewer to 6 inches above the top of sanitary sewer and one quarter of the pipe diameter or 6 inches, whichever is greater, on the side of the sanitary sewer.
6. Not allowed.

Table 7.5
PROTECTION REQUIREMENTS AT
WATER LINE - FORCE MAIN CROSSINGS

PRIMARY CONDITION	PROPOSED WATER EXISTING FORCE MAIN				PROPOSED WATER PROPOSED FORCE MAIN OR EXISTING WATER PROPOSED FORCE MAIN			
SECONDARY CONDITIONS	WATER OVER FORCE MAIN		WATER UNDER FORCE MAIN		WATER OVER FORCE MAIN		WATER UNDER FORCE MAIN	
IF THE CLEARANCE IS	Less than 2'	Greater than or equal to 2' but less than 9'	Less than 2'	Greater than or equal to 2' but less than 9'	Less than 2'	Greater than or equal to 2' but less than 9'	Less than 2'	Greater than or equal to 2' but less than 9'
*Protection Requirement	1,2,3	2	6	4	1,3,5	2	1,3,5	5

*** PROTECTION REQUIREMENTS FOR FORCE MAIN CROSSINGS**

(Unless Variance is Granted by the TCEQ)

(All clearances shall be measured from outside wall to outside wall)

- Place one full section of approved restrained joint water line centered at force main. Not applicable for existing water.
- If no evidence of force main leakage, place one full section of water line centered over sanitary sewer; if there is evidence of leakage, use note 4 below.
- One foot minimum clearance.
- Auger 9 feet minimum each side of force main. Place one full section of water line, centered under force main. Fill augered hole with bentonite/clay mixture. If force main is leaking, force main shall be replaced with 150 psi lined ductile iron or PVC pipe with appropriate adapters on all portions of the force main within 9 feet of the water line. Provide restrained joints for both water and sanitary sewer lines at each end of proposed pipe section. Water line must pass a pressure and leakage test as specified in City's Standard Specifications. Force Main line shall pass an infiltration, ex-filtration low pressure air test or leakage test as specified in TCEQ Chapter 317-2 Design Criteria for Sewage Systems.
- Place minimum one full section of force main, 150 psi lined ductile iron or PVC pipe centered at the water line and provide restrained joints for both water line and force main at each end of proposed pipe section. Use cement-stabilized sand backfill for all portions of the force main within 9 feet of the water line, as measured perpendicularly from any point on the water line to the force main (minimum 2.5 sacks cement per cubic yard of sand). The cement-stabilized sand bedding shall start at a point 6 inches below the bottom of the force main to 6 inches above the top of the force main and one quarter of the pipe diameter or 6 inches, whichever is greater, on the side of the force main.
- Not allowed.

- Sanitary Sewer Manholes: Provide a minimum 9-foot clearance from outside wall of existing or proposed manholes unless manholes and connecting sewers can be made watertight and tested for no leakage. If a 9-foot clearance cannot be obtained, the water line may be located closer to the manhole when prior approval has been obtained from OCE Division by using one of the procedures below; however, in no case shall the clearance be less than 4 feet.

- a. Encase water line in a steel casing pipe. Install by open-cut construction. Backfill with compacted cement-stabilized sand backfill.
 - b. Water lines 12-inch diameter and smaller may be augered past the manhole with one full section of pipe, minimum 150 psi, with approved restrained joints, installed centered about the existing sanitary manhole with pressure grouting using a bentonite/clay mixture.
4. Fire Hydrants: Do not install fire hydrants within 9 feet of sanitary sewers and force mains regardless of construction.
5. TCEQ Rules and Regulations for Public Water Systems, including any approved City variances shall apply if they are more strict than these guidelines or if they are not covered by these guidelines.

7.04 SUBMITTALS

- A. Conform to the following submittal requirements in addition to those of Chapter 1 - General Requirements.
- B. Water Line Sizes: Submit justification, calculations, and locations for proposed 2-inch diameter lines and for lines 12-inch diameter and larger, for approval by OCE Division, unless pipe sizes are specified to the design engineer by OCE Division.
- C. Water Meter Service.
 1. For construction inside city limits, submit an application for meter services and metered sprinkler connections, to the Taps and Meters Section, prior to construction.
 2. Submit requests for more than one service meter for townhomes in proposed private street developments to OCE Division.
- D. Master Development Plan: For multiple phase developments, submit a master development plan. If within the ETJ, submit an overall district plan prior to the drawings being submitted for first phase construction.
- E. Interconnections.
 1. Submit to the TCEQ requests for written approval of:
 - a. Connection of City water lines to serve districts or areas outside city limits.
 - b. Interconnections of districts.

2. Submit copies of approvals received from TCEQ to OCE Division.

7.05 QUALITY ASSURANCE

- A. Prepare calculations and construction drawings under the supervision of a Professional Engineer trained and licensed under the disciplines required by the drawings. The final design drawings must be sealed, signed, and dated by the Professional Engineer responsible for development of the drawings.

7.06 DESIGN ANALYSIS

- A. Water Line Sizes: Analyze system requirements to determine line sizes, unless sizing is provided to the design engineer by OCE Division in advance.
- B. Elevated Stream, Ditch, or Aerial Crossings: Prepare appropriate design calculations for the supporting structure.

7.07 DRAWINGS

- A. Conform to the following drawing requirements in addition to those of Chapter 3, Graphic Requirements and the City's standard water line details and Standard Specifications.
- B. Provide a cross section drawing (plan and profile) of branch water lines that extend perpendicularly from main water lines when:
 1. Branch line extends 20 feet or more, and
 2. Branch lines have vertical bends.
- C. Appurtenances: Identify, describe, and enclose in rectangular box on drawings.
 1. Valves.
 - a. Designate 2-inch through 20-inch gate valves with box as GV&B.
 - b. Provide complete description and size for other valves.
 2. Water meters, service leads, and un-metered sprinkler connections.
 - a. Show the location of service line tees, tapping sleeve and valves, valve boxes, and temporary plugs to be installed to serve future 3-inch diameter or larger meters.

- b. Develop plan and profile sheets for 4-inch diameter and larger leads and connections that cross public rights-of-way or other public utilities.
- D. Construction Features.
 - 1. Show special construction features required to complete the project in a safe, convenient, and economical manner.
 - 2. Auger Construction.
 - a. If the construction is predominately open cut, all portions of the street that must be augered shall be clearly shown on drawings by location and length. Include designation for auger sections adjacent to trees with 6 inches or larger diameters located within 10 feet of water line.
 - b. If construction is predominately by auger;
 - (1) Clearly show on drawings, areas in which auger pits will not be permitted, by location and length.
 - (2) Clearly identify areas where special pipe material or offset sections are required to comply with these guidelines.
 - 3. Do not locate horizontal bends within street intersections between curb returns.
 - 4. Curbs: Include a requirement on drawings for construction of wheelchair ramps at street intersections where curbs are to be removed or are damaged by water line construction. Conform to latest edition of City standards for wheelchair ramps.

END OF CHAPTER

City of Houston

Design Manual

Chapter 8

**WASTEWATER COLLECTION SYSTEM
DESIGN REQUIREMENTS**

Chapter 8

WASTEWATER COLLECTION SYSTEM DESIGN REQUIREMENTS

8.01 CHAPTER INCLUDES

- A. Criteria for the design of wastewater collection systems.
- B. This Chapter addresses the design of the wastewater collection systems within the public right-of-way or a dedicated public easement. Sanitary sewers located on private property, that are not in a dedicated easement, are under the jurisdiction of the Plumbing Code, and will be reviewed by the Code Enforcement Division.

8.02 REFERENCES

- A. Refer to the list of references in Chapter 1, General Requirements.
- B. City of Houston Engineering Design Manual for Submersible Lift Stations.
- C. City of Houston Design Guideline Drawings for Submersible Lift Stations.

8.03 DEFINITIONS

- A. Public Sewer - A closed conduit which conveys wastewater flow and which is located within the public right-of-way or dedicated public easement. A public sewer (or public sewer system) is intended to serve more than one residential, commercial, or industrial site.
- B. Private Sewer - A closed conduit which conveys wastewater flow and is constructed and maintained by a private entity (i.e., homeowner's association). Private sewers may be located in areas such as a private street or common area. Private sewers are subject to the design and construction requirements of the Plumbing Code and must discharge to a public sewer.
- C. Sewer Main - A sewer which receives the flow from one or more lateral sewers.
- D. Lateral Sewer - A sewer running laterally down a street, alley, or easement which receives flow only from abutting property.
- E. Building Connection Easement - An easement dedicated to the City of Houston which allows a property owner to extend a private sewer or service connection across adjacent property, or properties, to facilitate connection to a public sewer. A building connection easement shall be 10 feet wide (minimum).

- F. Service Lead - A sewer which branches off of a public sewer and extends to the limits of the public right-of-way. It shall be construed as having reference to a public sewer branching off from a main or lateral sewer to serve one or more houses, single-family lots, or other types of small land tracts situated in the same block, but not directly adjacent as the main or lateral sewer. Such a line shall never exceed 150 feet in length. If the sewer is designed to serve more than two houses, or the equivalent of two single-family residences along a street, a lateral sewer as defined above shall be constructed.
- G. Service Connection - A private sewer from a single source to the main or lateral sewer in the street, alley, or adjacent easement. Service connections are covered by the building code. If routed through another tract of land, it shall be located in a building connection easement. If located within a private easement, the City must be included as a third party in the easement documents. It will be owned and maintained by the owner of the property being served by the private sewer.
- H. Project Area - The area within the immediate vicinity of a public sewer to be constructed.
- I. Stack - A riser pipe constructed on main or lateral sewers which are deeper than 8 feet to facilitate construction of service leads or service connections.
- J. Force Main - A pressure-rated conduit (i.e., ductile iron pipe, pressure-rated PVC, etc.) which conveys wastewater from a pump station to a discharge point.

8.04 DESIGN REQUIREMENTS

- A. Drawings to be Furnished.
 - 1. Before any main or lateral sewer is constructed and before a permit will be issued for the construction, plan-and-profile sheets of the proposed sewer shall be prepared and submitted to the City for approval.
 - 2. On projects within the city limits, the tracing shall become the property of the City and shall remain on file in the City for use by any person who may be interested in the project.
- B. Details to be Shown on Drawings: The detailed drawings will show the exact location of the proposed line in the street, alley, or easement with respect to the edge of the particular right-of-way, the transit base line, and any nearby utilities, 100-year flood elevation within the project area, major landscaping, and other structures affecting construction.
- C. Main and Lateral Sewers.
 - 1. Sewers shall be identified by number, letter, or other identification as shown on the sanitary sewer layout sheet and manholes identified by letter or number.

2. Sewers in curved easements, easements defined by property lines and combined easements containing other public utilities must be shown in both plan-and-profile views.
3. The profile shall show other underground and surface utilities and facilities, both in parallel and at crossings; the size, grade of the proposed line, the elevations of the proposed line to hundredths of a foot at manholes, changes of grade and dead ends; and the proposed finished grade over the sewer. It should show the actual ground line as it exists prior to construction of the sewer. Where proposed fill or cut is contemplated, the proposed new ground line should be shown as a separate line from the actual ground line. Type of pipe and bedding shall comply with City of Houston Standard Specifications and Standard Details
4. Where sewers are to be placed between existing pavement and the street right-of-way line (or interior easement line) or under existing pavement or topping, show the existing ground line at both sides (or the closest side for sewers near the edge) of the right-of-way or adjacent sewer easement.

D. Plan and Profile Required for Sewer Mains.

1. Sanitary sewer layouts for single-family residential subdivisions should use a scale of 100 feet or less per inch. A scale of 200 feet per inch may be used provided the following information is shown on the layout:
 - a. All easements containing or buffering sanitary sewers are shown and labeled both as to width and type; sewer sizes are shown at points of size changes; manhole locations are shown.
 - b. The sewer alignment shall accurately reflect the relative location of the sewer as shown on the detailed plan view.
 - c. Service leads that cross street pavement or serve adjacent property are to be shown on the layout. The detail plans and profiles shall show the flow lines of service leads at the street or easement right-of-way.
 - d. The number and size of the lots depicted on both the overall sewer layout sheet and the individual plan-and-profile sheets shall match the number and size of the lots depicted on the final plat after recordation.
 - e. The size and direction of flow for existing and proposed sewers shall be shown on the overall sanitary sewer layout sheet.
 - f. The location of the proposed sewer within either the public right-of-way, a dedicated easement adjacent to the public right-of-way, or side lot easement (if allowed by the City).

- g. The overall sanitary sewer layout sheet shall show the area, in acres, which the proposed sewer is designed to serve. Include a location map which references the acreage to nearby major thoroughfares and boulevard streets. The scale of the location map shall be 1" = 2000' or less.
- 2. Commercial sanitary sewer layouts for large areas and with a scale of 400 feet or more per inch must have an additional set of layouts at not more than 200 feet per inch, with match lines and a small index map showing which portion of the overall layout that the layout of each sheet represents.
- 3. Acceptable horizontal scales for the detailed plan-and-profile views are 10 feet, 20 feet, 40 feet, and not more than 50 feet maximum per inch. Horizontal scale for major thoroughfares and boulevard streets shall be 1" = 20' or less.
- 4. Acceptable vertical scales for detailed profile views are 2 feet, 4 feet, and not more than 5 feet maximum per inch unless otherwise approved. Vertical scale for major thoroughfares and boulevards shall be 1" = 2' or less.
- 5. The plan view shall show, at a minimum, the following information for the project area:
 - a. Topographical features.
 - b. Stationing for the proposed sewers.
 - c. Existing utilities (i.e., telephone, gas, HL&P, etc).
 - d. Any significant landscaping or other structures which might impact construction or construction-related activities.
 - e. The width and type of existing and proposed easements.
 - f. Proposed service leads.
 - g. The limits of bore or tunnel.
 - h. Locations where pressure pipe is to be installed for water line crossings.
- 6. The profile view shall show, at a minimum, the following information for the project area:
 - a. Underground and surface utilities/facilities which are either parallel to the proposed sewer or cross the proposed sewer.
 - b. The proposed sewer's diameter and grade for each manhole section.

- c. The flowline elevation for sanitary sewers at each manhole.
 - d. The rim elevation of existing and proposed manholes.
 - e. The flowline elevation at each sheet break (i.e., from one sheet to another).
 - f. Type of pipe bedding and backfill shall be included in the Standard Details.
 - g. The finished grade for proposed and existing pavement. Where cut and fill are proposed, the proposed new ground line should be shown as a separate line from the existing ground line.
 - h. The existing ground line for the near side of the public right-of-way where a sewer is to be placed between the edge of existing pavement and the edge of the public right-of-way.
 - i. The existing ground line at the centerline of the proposed sanitary sewer where a sanitary sewer is to be placed within an existing easement. Show any proposed cut and fill as described above. Show the finished grade of any proposed and existing pavement.
 - j. The flowline elevation of service leads where the service lead crosses the edge of the public right-of-way or the dedicated easement adjacent to the public right-of-way.
 - k. The limits of bore or tunnel.
 - l. Locations where pressure pipe is to be installed for water line crossings.
 - m. The location of special backfill and proposed stacks shall be identified by stations indicated on the design plans.
 - n. Avoid vertical breaks in the profiles. Include additional profile sheets where depth of sanitary sewers warrant.
7. Drawings for single-family residential subdivisions shall show the proposed location, by stations, of all service leads, service connections, and stacks.

E. Service Leads.

- 1. Service leads shall be located either at the property line between two adjoining lots, or every 100 feet, whichever is less or as directed by the City. A single 6-inch service lead located at the property line between two adjoining lots would serve two single-family residences with a wye placed at the end of the service lead. Do not extend the wye beyond the edge of either the public right-of-way or dedicated easement.

2. Any service lead extension of more than 50 feet parallel to the street right-of-way shall be treated as a lateral sewer.
3. Service leads for single-family developments shall not connect to the manhole unless otherwise stated in this manual. Service leads from developments with more than 5000 gallons-per-day flow shall discharge into a proposed or existing manhole. Where the flow line of the service lead is 30 inches or greater above the flow line of the manhole, provide a standard City of Houston drop manhole.
 - a. Service leads shall be provided to serve each lot within proposed development, whether inside the city limits or in the ETJ. Provide detail for typical near-side and far-side service leads.
 - b. Service leads shall be 6 inches in diameter (minimum). If the length of a service lead exceeds 100 feet or the width of the public right-of-way by more than 20 feet, the minimum diameter shall be 8 inches and a manhole shall be utilized for connection to the public sewer.
 - c. Service leads with a diameter of 6 inches shall utilize full body fittings (extruded or factory-fabricated) for connection to a proposed public sewer or an approved saddle-type connector for connection to an existing public sewer.
 - d. Saddle-type connectors shall be installed with the stub oriented between the springline (3 o'clock and 9 o'clock positions) and 45 degrees from the springline (1:30 and 10:30 positions). Tees (i.e., full body fittings) shall be oriented in the same manner.
 - e. The service lead shall be designed to minimize the use of bends as site conditions will permit.
 - f. Service leads exceeding the limits defined in Paragraph 8.04E.2 shall have a manhole at each end; as well as a plan-and-profile drawing for each right-of-way crossing. All or part of these service leads which are located in a public right-of-way, alley or dedicated sanitary sewer or public utility easement may be treated as a public sewer; depending upon the location of the terminal manhole and any intermediate manholes.
 - g. For existing lots (which are not served in accordance with these guidelines) that need a service lead, if the distance to the nearest existing sewer is less than 50 feet, the service lead is under the jurisdiction of the Plumbing Code.
 - h. The location where the service lead crosses the property line shall be shown on the plans and marked in the field. Provide a typical detail of durable marker placed where the service lead crosses the property line.

F. General Requirements.

1. Connect to stacks and wyes or tees as shown. Where no stacks are shown, a licensed plumber is responsible for placing a City-approved saddle for connection to the public sewer and the City Inspector is responsible for determining that the saddle is watertight and properly installed.
2. Materials and construction shall conform to latest City of Houston Standard Specifications, including standard leak test.
3. Unless noted otherwise, all public sewers and service leads shall be embedded in cement-stabilized sand from 6 inches below the pipe to 12 inches above the pipe and for the full trench width. All such bedding shall be compacted to the density required by Standard Specifications. Cement-stabilized sand shall have a 48-hour compressive strength of 100 psi. The cross-section described in this paragraph is defined as the embedment zone.
4. Backfill excavated areas and trenches under or within one foot of existing or proposed pavement with cement-stabilized sand from the top of the pipe embedment zone up to one foot below the paving subgrade. Cement-stabilized sand must develop 100 psi compression at 48 hours. Backfill shall be compacted to 95 percent standard Proctor density.
5. The actual location of all special backfill and of proposed stacks shall be shown by stations in the drawings.
6. Public sewers and force mains shall be located in either the public right-of-way or easements. Side lot easements may be used only with special approval. Backlot easements shall not be utilized except in cases of preexisting conditions as approved. Generally, the location of the public sewer within a dedicated easement shall be along the centerline of the easement. However, in those instances where the easement is adjacent to the public right-of-way, the location of the sanitary sewer shall be approved on a case-by-case basis by the Director, Department of Public Works and Engineering. Required easement widths are addressed in Chapter 5, Easement Requirements. Additional information regarding the location of sanitary sewers is contained in Chapter 6, Utility Locations.
7. The final determination as to that portion of a street, alley, or easement to be occupied by a proposed sewer rests within the City. The Director will take into consideration existing, planned and proposed facilities such as manholes, pavement, pipes/conduits, along with existing trees and shrubs, or other unique surface conditions when arriving at a decision.
8. There shall be no closed-end easements for sanitary sewers.

9. The drawings for the sewer shall show the location of any existing known pipe or duct that might interfere with the construction of the sewer and call to the attention of the City any known obstacles that might be encountered in constructing the sewer in any location under consideration. The Professional Engineer shall determine the existence of pipes, ducts, and obstacles from a visual survey on the ground plus research of public records and private records when available.

G. Line Size.

1. The minimum pipe diameter for a public sanitary sewer shall be 8 inches.
2. Service leads 4 inches in diameter shall be confined to the limits of the lot which they serve and shall serve only the equivalent of one single-family lot. No 4-inch sewer shall be laid in any street, alley, or right-of-way.
3. Service leads 6 inches in diameter shall not serve more than the equivalent of 2 single-family lots or other types of small land tracts.
4. Service leads of 6-inch and 8-inch diameter for single-family residential lots shall have a minimum grade of 0.70 percent and 0.44 percent respectfully.
5. For commercial service leads such as street bores, submit a copy of the approved plumbing drawings to establish the required size of the line. The minimum size lead shall be 8 inches in diameter downtown and 6 inches in diameter elsewhere.
6. Main and lateral sewers will end in manholes, except for special or unusual situations and are subject to specific approval by the City.
7. Sewer lines shall be laid at a size and depth to conform to designs permitting an orderly expansion of the sewer system of the City and so as to avoid a duplication of lines in the future.
8. The City shall be the final judge as to sizes and depths required and exceptions to lateral service leads as previously defined.

H. Line Depth.

1. The sewer should be laid with the top of the pipe a minimum of 3 feet below the surface of the ground.
2. Sewers laid in street rights-of-way with curb and gutter paved streets shall have a minimum cover of 4 feet from the top of the pipe to top of the curb to anticipate future sewer extension.

3. Sewers laid in street rights-of-way with crowned roads and side ditches shall have a minimum cover of 6 feet from the average ground line at the adjacent street right-of-way to the top of pipe.
4. Where the minimum cover as specified in Paragraphs 8.04H.1, 8.04H.2, and 8.04H.3 is not possible, the sewer shall be laid with Class 150 (150 psi) pressure pipe with cement stabilized sand backfill as shown in Standard Details. Ductile iron pipe shall be lined with either a polyethylene or polyurethane coating as approved by the pipe manufacturer and applied by either the pipe manufacturer or an approved applicator. The minimum liner thickness shall be 40 mil.
5. Maximum depth for 8-inch-, 10-inch-, and 12-inch-diameter collection lines shall be 20 feet from average ground surface to pipe invert. Depths greater than 20 feet are subject to approval by the City Engineer if justified for site specific reasons during the preliminary engineering phase of the project design.

I. Line Grades.

1. The following table lists the minimum grades for 6-inch to 27-inch diameter public sewers. The minimum grade is based on a minimum full pipe velocity of 2.3 feet per second (fps). The maximum recommended grade is based on a maximum full pipe velocity of 4.5 fps. In both cases, the Manning Formula has been used with an n coefficient of 0.013. The use of different pipe materials will not alter the use of 0.013 for the purposes of the Design Manual.

Table 8.1
MINIMUM GRADES FOR WASTEWATER LINES

NOMINAL INTERNAL PIPE DIAMETER (INCHES)	MINIMUM GRADE TO DEVELOP V=2.3 FPS (PERCENT)
6	0.65
8	0.44
10	0.33
12	0.26
15	0.19
18	0.15
21	0.13
24	0.11
27	0.087

2. For sewers larger than 27 inches in diameter, the Professional Engineer of record shall determine the appropriate grade utilizing the Manning Formula, $n=0.013$ and a minimum full pipe velocity of 3.0 fps.
- J. Alignment: Gravity sewers shall be laid in straight alignment with uniform grade between manholes. Deviations from straight alignment shall be justified by complying with the TCEQ's requirements and approved by the City. Deviations from uniform grade without manholes shall not be allowed.
- K. Manholes.
1. Type: Manholes shall be either precast concrete, per Standard Details; unless the Professional Engineer submits a cast-in-place manhole design for review and approval by the City. The Professional Engineer of record shall determine the need for a liner or coating on concrete manholes. Liner or coatings will be in accordance with the approved products as determined by the City of Houston Standard Products Committee. Fiberglass manholes, per Standard Details, are allowed outside paved areas. Precast manholes shall incorporate a boot-type connector for sewer diameters up to 24 inches. For sewer diameters greater than 24 inches, utilize either the boot-type connector (if available) or an integral gasket. Precast manholes shall conform to the latest ASTM requirements. Manhole covers shall be 32 inches as shown in the Standard Details. Variances will be considered for interior drops on existing manholes.
 2. Location: For public sewers, manholes shall be placed at changes in alignment, changes in grade, junction points, and either at street, alley, or easement intersections as designs may require.
 - a. Sewers laid in easements shall have a manhole in each street crossed by the sewer.
 - b. The maximum distance between manholes shall be determined from the following table for 8-inch to 48-inch pipe diameters. Spacings for manholes on mains with diameters larger than 48 inches installed by tunneling methods or open-cut methods shall be determined on an individual project basis.

Table 8.2
MAXIMUM DISTANCE BETWEEN
SANITARY SEWER MANHOLES

PIPE DIAMETER (I.D.) IN INCHES	MANHOLE MAXIMUM SPACING IN FEET
8-15	400
18-48	800
Greater than 48	As approved by the City

- c. A design objective is to have sewers with the same, or approximately the same, flowline elevation intersect each other at a 90-degree angle. However, where a true perpendicular intersection cannot be obtained, and where the entering sewer intersects the receiving sewer at, or about, the same flowline elevation, one or more manholes shall be located so that a minimum angle of 80 degrees at the point of intersection can be achieved for the sewer line. When the entering sewer is on the upstream side of the manhole, the minimum angle between the sewers may be reduced to a 45 degree angle provided:
- (1) A distinct flow channel can be maintained within the manhole when the flowline elevations of the sewers are at or within one pipe diameter of the smaller pipe; or
 - (2) When the flowline elevation of the entering pipe is above the crown of the primary sewer and clearance can be provided between the sewers.
- d. Place manholes at the dead-end of mains and laterals.
- e. Existing manholes located within the city limit shall be identified by the alphanumeric system established by the Department. Refer to Department's "GIMS" map.
- f. Criteria for Connections to and Utilization of Manholes:
- (1) Connections between public sewers at the manhole shall adhere to the following criteria when possible:
 - (a) The elevation of the crown of the discharging sewer shall either match the elevation of the crown of the receiving sewer or be approved as a special case by the City.
 - (b) A standard drop connection as shown in City of Houston Standard Details is required when the difference in elevation between discharging sewer flow line and receiving sewer flow line is greater than 30 inches.

- (2) The routing of a service connection directly to an existing manhole will be allowed only if:
 - (a) The flow line elevation of the existing sanitary sewer is more than 10 feet below grade and there is no available stack and the lot to be so connected is a single-family, owner-occupied, single lot residence connection to an existing manhole; or
 - (b) The lot to be so connected is a single-family, single lot connecting to a manhole at the end of a cul-de-sac.
 - (c) Satisfies discharge requirements of service leads requiring manholes (see Paragraph 8.04E.3).
- (3) When routing an approved service connection to a manhole (see Paragraph 8.04K.2.f(2)), the wall penetration shall not be greater than 10 inches in diameter and shall be sealed using an approved grout.
- (4) When routing an approved service connection to an existing manhole (see Paragraph 8.04K.2.f(3)) with invert elevation more than 30 inches lower, the connections shall utilize a drop and shall adhere to the following criteria:
 - (a) The manhole wall penetration shall not be greater than 10 inches in diameter;
 - (b) The drop shall be a minimum of 6 inches in diameter and shall be constructed of SDR 26 PVC pipe (ASTM D 3034);
 - (c) The drop shall be located 45 degrees from the upstream side of the main sewer;
 - (d) Usage of an internal drop will be reviewed on a case-by-case basis. A minimum of 48 inches of clear space shall be maintained inside the manhole and the drop shall be affixed to the manhole wall utilizing stainless steel bands and anchor bolts;
 - (e) An internal drop shall terminate with a 45 degree bend. The 45-degree bend shall not extend below the top-of-pipe elevation of receiving sanitary sewer; and
 - (f) The wall penetration shall be sealed using an approved grout.
- (5) Public sewers shall terminate in a manhole. Clean-outs will not be utilized except at the end of each service lead.

L. Lift Stations.

- 1. Lift station design shall comply with the City of Houston Engineering Design Manual for Submersible Lift Stations and Design Guideline Drawings for Submersible Lift Stations, latest revision. The designer shall submit a Final Design Submittal Checklist (available from the City), signed and sealed by the Design Engineer, to ensure that the lift station is designed in compliance with the requirements of applicable codes and regulations. Include a copy of the Engineering Design Report satisfying TCEQ criteria.

2. Provide Level II controls for City lift stations. Level I controls may be used for non City owned lift stations.
3. Wet wells.
 - a. Use procedures outlined in “Engineering Design Manual for Submersible Lift Stations” to size wet wells. Verify the design with “Design Guideline Drawings for Submersible Lift Stations.”
 - b. Provide adequate clearance between pumps.
4. Lift station site - Minimum size of 50 feet by 50 feet.

8.05 UNSEWERED BUILDING SITES AND SEPTIC TANK SUBDIVISIONS

A. Lot Size and Requirements.

1. Lot sizes shall be determined by the projected use of the property considering people density, sewage requirements, soil tests (percolation tests performed and certified to by the Professional Engineer) and public or private water supply, all in accordance with the requirements of the latest edition of Chapter 285 of TCEQ regulations.
2. The location of the individual lot sewage treatment facilities and the location of the private water well, if required, shall be shown on individual building drawings.
3. Platted subdivisions served by public water supply should provide for individual lots having surface areas of at least 15,000 square feet.
4. Platted subdivisions served by individual water systems should provide for individual lots having surface areas of at least 20,000 square feet.
5. Engineer shall conform to applicable county criteria for Paragraphs 8.05A.3 and 8.05A.4 if more stringent.

- B. Commercial establishments require a septic system design prepared by a Professional Engineer in accordance with the latest edition of Chapter 285 of TCEQ regulations. Building permits for commercial buildings shall require a sewer availability letter approving a septic system designed and sealed by a Professional Engineer.

8.06 SUBMITTALS

A. Preliminary Design - Submit the following for review and comment:

1. Copies of any documents which show approval of exceptions to the City design criteria.

2. Design calculations for line sizes and grades.
3. Contour map for overall area.
4. Plan-and-profile sheets showing proposed improvements (City projects only).
5. Geotechnical soils report for the project (City projects only).

B. Final Design - Submit the following for approval:

1. Final documents of the above plus plan-and-profile sheets and geotechnical soils reports for non-City projects.
2. Review prints.
3. Original drawings.
4. Complete copy of specifications.
5. A final engineering design report shall be developed following TCEQ Chapter 317 and submitted to the City for each project. This report shall bear the signed and dated seal of a professional engineer registered in the State of Texas who is responsible for the design.

8.07 QUALITY ASSURANCE

- A. Prepare calculations and construction drawings under the supervision of a Professional Engineer trained and licensed under the disciplines required by the drawings. The final construction drawings must be sealed, signed, and dated by the Professional Engineer responsible for the development of the drawings.

8.08 RESEARCH REQUIREMENTS

- A. Discuss project concepts outlining proposed features and usage with City of Houston, Department of Public Works and Engineering.
- B. Research existing utility and right-of-way information.
- C. Verify that no restrictions exist that will deny approval of the project concept.

8.09 DESIGN ANALYSIS

- A. Calculations of design flows for overall development project.
- B. Calculations for design of any treatment plant required for the development.

- C. Calculations for effect of the 25-year storm outfall from any proposed treatment plant.

8.10 DRAWINGS

- A. Drawings shall include layout sheets with contours, plan-and-profile sheets, and detail sheets for special items and treatment plants.

END OF CHAPTER

City of Houston

Design Manual

Chapter 9

STORMWATER DESIGN REQUIREMENTS

Chapter 9

STORMWATER DESIGN REQUIREMENTS

9.01 CHAPTER INCLUDES

- A. Criteria for the design of storm drainage improvements.

9.02 DRAINAGE POLICY

- A. Design Requirements.

1. Drainage criteria administered by the City of Houston and complemented by Harris County and the Harris County Flood Control District (HCFCD) for newly designed areas provides protection from Structural Flooding from a 100-year storm event. This is accomplished through application of various drainage enhancements, such as storm sewers, roadside ditches, open channels, detention and overland (sheet) run-off. The combined system is intended to prevent Structural Flooding from extreme events up to a 100-year storm.
2. Recognizing that each site has unique differences that can enhance the opportunity to provide proper drainage, the intent of these criteria is to specify minimum requirements that can be modified provided that the objective for drainage standards is maintained.

- B. Street Drainage: Street ponding of short duration is anticipated and designed to contribute to the overall drainage capability of the system. Storm sewers and roadside ditch conduits are designed as a balance of capacity and economics. These conduits are designed to convey less intense, more frequent rainfalls with the intent of allowing for traffic movement during these events. When rainfall events exceed the capacity of the storm sewer system, the additional run-off is intended to be stored or conveyed overland in a manner that reduces the threat of flooding to structures.

- C. Overland Run-off: Proposed New Development, Redevelopment, or In-fill Development shall not alter existing overland flow patterns and shall not increase or redirect existing Sheet Flow to adjacent private or public property. Sheet Flow from the developed property shall discharge only to the abutting public right-of-way. Where the existing Sheet Flow pattern is blocked by construction (i.e. raising the site elevation) of the Development, the Sheet Flow shall be re-routed within the developed property to return flow to original configuration or to the public right-of-way. Except under special circumstances dictated by natural drainage patterns, no Sheet Flow from the developed property will be allowed to drain onto adjacent private property.

- D. Flood Control: The City of Houston is a participant in the National Flood Insurance Program (NFIP). The flood insurance program makes insurance available at low cost where the municipal entity implements measures that reduce the likelihood of Structural Flooding. The design criteria in this chapter are provided to support the NFIP. All development shall comply with Chapter 19, FLOOD-PRONE AREAS, of the Code of Ordinances if located within the City limits.
- E. Relationship to the Platting Process: Approval of storm drainage is a part of the review process for planning and platting of a New Development. Review and approval of plats is conducted by the Department of Planning and Development. Review of storm drainage is conducted by the Department of Public Works and Engineering (PWE).
- F. Development in Areas that have Deficient Drainage Systems: The City will consider joint project funding with a private entity for construction of drainage systems that improve existing drainage infrastructure. The City's first priority will be to fund those projects included in the Capital Improvement Plan (CIP). Where feasible, City funding will be leveraged with other funding sources including private entities, civic organizations, and other public agencies (Harris County, HCFCD, Corps of Engineers, Housing and Community Development, and other funding sources). For drainage systems that have been identified as deficient and are not scheduled to receive funding in the current CIP, the City will consider authorizing improvements performed by the private entity that comply with the City's objectives.
- G. The criteria in this Chapter apply to all projects located in the City limits and to expanding utility districts and new utility districts located in the City's Extraterritorial Jurisdiction (ETJ). If the criteria conflicts with Harris County, HCFCD, Fort Bend County, Montgomery County or other jurisdictions the most restrictive criteria shall govern.

9.03 REFERENCES

- A. Refer to the list of references in Chapter 1, General Requirements.
- B. National Weather Service Documents.
 - 1. TP-40 Rainfall Frequency Atlas of the United States.
 - 2. Hydro-35; 5-to-60-Minute Precipitation Duration for the Eastern and Central United States.

- C. Hydraulic Engineering Circular No. 22, (HEC-22) Second Edition, "Urban Drainage Design Manual", Federal Highway Administration (FHWA).
- D. ASCE Manual and Reports of Engineering Practice No. 77, Design and Construction of Urban Stormwater Management Systems, 1992.
- E. HouStorm – The City of Houston's version of The Texas Department of Transportation's (TxDOT) WinStorm software.
- F. HCFCFCD Policy, Criteria, and Procedure Manual (HCFCFCD Criteria Manual).

9.04 DEFINITIONS

- A. Conduit - Any open or closed device for conveying flowing water.
- B. Continuity Equation:

	Q	=	VA
Where:	Q	=	discharge (cfs or cms)
	V	=	velocity (ft/sec or m/sec)
	A	=	cross sectional area of Conduit (square feet or square meters)
- C. Design Storm Event - Rainfall intensity upon which the drainage facility will be sized.
- D. Development – The term includes New Development, Redevelopment, and In-fill Development.
 - 1. In-fill Development - Development of open tracts of land in areas where the storm drainage infrastructure is already in place and takes advantage of the existing infrastructure as a drainage outlet.
 - 2. New Development – Development of open tracts of land in areas where the storm drainage infrastructure has not been constructed and a drainage outlet must be extended to a channel under the jurisdiction of the HCFCFCD.
 - 3. Redevelopment - A change in land use that alters the impervious cover from one type of Development to either the same type or another type, and takes advantage of the existing infrastructure in place as a drainage outlet.
- E. Drainage Area Map - Area map of watershed which is subdivided to show each area served by each subsystem.
- F. FEMA - Federal Emergency Management Agency.
- G. HCFCFCD - Harris County Flood Control District.

- H. HouStorm – The City of Houston’s version of TxDOT’s WinStorm software. The program is available from the City or at www.swmp.org.
- I. Hydraulic Grade Line - A line representing the pressure head (water surface elevation) available at any given point within the drainage system.
- J. Manning's Equation:
- $$V = (K/n)R^{2/3}S_f^{1/2}$$
- Where:
- | | | |
|----------------|---|---|
| K | = | 1.49 for English units,
1.00 for metric units |
| V | = | velocity (ft./sec or m/sec) |
| R | = | hydraulic radius (ft. or m) (area/wetted perimeter) |
| S _f | = | friction slope (headloss/length) |
| n | = | 0.013 for concrete pipes,
0.015 for concrete boxes,
0.024 for CMP pipes |
- K. Rainfall Frequency - Probability of a rainfall event of defined characteristics occurring in any given year at a given location. Information on Rainfall Frequency is published by the National Weather Service. For the purpose of storm drainage design, the following frequencies are applicable:
1. 2-year frequency - a rainfall intensity having a 50 percent probability of occurrence in any given year, that occurs on the average every 2 years over a long period of time.
 2. 3-year frequency - a rainfall intensity having a 33 percent probability of occurrence in any given year, that occurs on the average every 3 years over a long period of time.
 3. 5-year frequency - a rainfall intensity having a 20 percent probability of occurrence in any given year, that occurs on the average every 5 years over a long period of time.
 4. 10-year frequency - a rainfall intensity having a 10 percent probability of occurrence in any given year, that occurs on the average every 10 years over a long period of time.
 5. 25-year frequency - a rainfall intensity having a 4 percent probability of occurrence in any given year, that occurs on the average every 25 years over a long period of time.
 6. 100-year frequency - a rainfall intensity having a 1 percent probability of occurrence in any given year, that occurs on the average every 100 years over a long period of time.

- L. Rational Formula - A method for calculating the peak run-off for a storm drain system using the following equation for run-off:

$$Q = I \times (CA)$$

Where:

C	=	watershed coefficient
A	=	area (acres)
I	=	rainfall intensity (inches per hour)

- M. Sheet Flow - Overland storm run-off that is not conveyed in a defined Conduit and is typically in excess of the capacity of the existing Conduit system.
- N. Structural Flooding – The water surface elevation from the storm event exceeds the top of slab elevation of the building (for pier and beam construction the top of first floor elevation), resulting in water entering the structure.

9.05 DESIGN REQUIREMENTS

- A. Design of drainage facilities shall meet requirements of the City of Houston Standard Specifications and Standard Details. HouStorm shall be used to perform design analysis and design of storm drainage systems as follows:

1. City of Houston CIP Projects – Required. In conjunction with design analysis using HouStorm, designs shall comply with guidelines provided in Technical Paper No. 100 (TP-100), Storm Sewer Design Applications for the City of Houston, Texas, Capital Improvement Plan Projects, February 2005, or the latest published date.
2. Private Projects within City Limits which include City funding participation – Required.
3. 100% Privately-funded Project located in City Limits – HouStorm preferred but alternative equivalent analysis procedures will be accepted.
4. Projects in New or Expanding Utility Districts located in City's ETJ - HouStorm preferred but alternative equivalent analysis procedures will be accepted.

- B. Determination of Run-off.

1. Design Storm Events.
 - a. Rainfall Duration:
 - (1) For design purposes, the rainfall duration for drainage areas less than 200 acres will be no less than 3 hours in duration.
 - (2) For design purposes, the rainfall duration for drainage areas more than 200 acres will be no less than 6 hours in duration.

- b. Intensity-duration Curves. Figure 9.1, City of Houston IDF Curves, depicts the intensity-duration curves to be used for storm sewer and roadside ditch design in the City of Houston and the ETJ. These curves were derived from the National Weather Service publications referenced in this Chapter.
 2. Application of Run-off Calculation Models.
 - a. Rational Method: The rational method will be used for design on areas served by storm sewers up to 600 acres in size and for areas served by roadside ditches up to 500 acres in size.
 - b. Rainfall Run-off Modeling: Rainfall run-off modeling will be applied to areas greater than 500 acres in size that are drained by an open channel. Rainfall run-off modeling can be used for modeling of storm sewer areas greater than 600 acres provided the model considers the storage and ponding in streets. If the modeling is associated with establishing a flood-prone area for purposes of a FEMA submittal, the models must be acceptable to that agency.
 3. Coefficients for the Rational Method.
 - a. Calculation of Run-off Coefficient.
 - (1) The run-off coefficient C values in the rational method formula will vary based on the land use. Land use types and C-values which can be used are as follows:

<u>Land Use Type</u>	<u>Run-off Coefficient (C)</u>
Residential Districts	
Lots more than 1/2 acre	0.35
Lots 1/4 - 1/2 acre	0.45
Lots less than 1/4 acre	0.55
Multi-Family areas	
Less than 20 Service Units/Acre	0.65
20 Service Units/Acre or Greater	0.80
Business Districts	0.80
Industrial Districts	
Light Areas	0.65
Heavy Areas	0.75
Railroad Yard Areas	0.30
Parks/Open Areas	0.18
 - (2) Alternatively, the run-off coefficient C in the rational method formula can be calculated from the equation:

$$C = 0.6/a + 0.2$$

Where: C = watershed coefficient

I/a = impervious area/total area

- (3) If the alternate form is to be submitted, the calculation of C shall be provided as part of the drainage calculations.

b. Determination of Time of Concentration.

Time of concentration can be calculated from the following formula:

$$TC = 10A^{0.1761} + 15$$

Where: TC = time of concentration (minutes)
A = subarea (acres)

c. Sample Calculation Forms.

- (1) Figure 9.2, City of Houston Storm Sewer Calculation Form, is a sample calculation form for storm sewer systems.
- (2) Figure 9.3, City of Houston Roadside Ditch Worksheet, is a sample calculation form for roadside ditch systems.

C. Design of Storm Sewers.

1. Design Frequency.

- a. New Development: The Design Storm Event for sizing storm sewers in newly developed areas will be a 2-year rainfall.
- b. Redevelopment or In-fill Development: The existing storm drain (sewer, ditch) will be evaluated using a 2-year design storm, assuming no development takes place. The storm drain will then be evaluated for the 2-year design event with the Development in place.
- (1) If the proposed Redevelopment has a lower or equal impervious cover, no modifications to the existing storm drain are required.
- (2) If the proposed Development results in the hydraulic gradient of the existing storm drain below the gutter line, no improvements to the existing storm drain are required. Detention shall comply with Paragraph 9.05.H. Flow discharged to the storm drain shall be in compliance with Paragraph 9.05.H.4.b.
- (3) If the analysis of the existing conditions finds that the existing storm drain is deficient (i.e. the hydraulic grade line is above the gutter line), the applicant should check with the City to see if a CIP project is proposed that will require a capital contribution. If a CIP project is not proposed for the subject system, then on-site detention will be required in accordance with Paragraph 9.05.H. Flow discharged to the storm drain shall be in compliance with Paragraph 9.05.H.4.b.
- c. City Projects (CIP): Proposed City capital improvements may indicate a larger diameter storm sewer is planned in the area proposed for drainage improvements. The Engineering and Construction Division of

PWE has information on proposed improvements and should be consulted for impact on New Development.

- d. Private Drainage Systems: Storm sewers for private drainage systems should conform to the City of Houston Uniform Building Code for development within the City limits.

2. Velocity Considerations.

- a. Storm sewers should be constructed to flow in subcritical hydraulic conditions if possible.
- b. Minimum velocities should not be less than 3 feet per second with the pipe flowing full, under the design conditions.
- c. Maximum velocities should not exceed 8 feet per second without use of energy dissipation downstream.
- d. Maximum velocities should not exceed 12 feet per second.

3. Pipe Sizes and Placement.

- a. Use storm sewer and inlet leads with at least 24-inch inside diameter or equivalent cross section. Box culverts shall be at least 2 feet by 2 feet. Closed Conduits; circular, elliptical, or box, shall be selected based on hydraulic principals and economy of size and shape.
- b. Larger pipes upstream should not flow into smaller pipes downstream unless construction constraints prohibit the use of a larger pipe downstream, or the improvements are outfalling into an existing system, or the upstream system is intended for use in detention.
- c. Match crowns of pipe at any size change unless severe depth constraints prohibit.
- d. Locate storm sewers in public street rights-of-way or in approved easements. Back lot easements are discouraged and will require a variance from the City design standards.
- e. Follow the alignment of the right-of-way or easement when designing cast in place concrete storm sewers.
- f. A straight line shall be used for inlet leads and storm sewers.
- g. Center culverts in side lot storm sewer easements.

4. Starting Water Surface and Hydraulic Gradient.
 - a. The hydraulic gradient shall be calculated assuming the top of the outfall pipe as the starting water surface.
 - b. At drops in pipe invert, should the upstream pipe be higher than the Hydraulic Grade Line, then the Hydraulic Grade Line shall be recalculated assuming the starting water surface to be at the top of pipe at that point.
 - c. For the Design Storm, the hydraulic gradient shall at all times be below the gutter line for all newly developed areas.
5. Manhole Locations.
 - a. Use manholes at the following locations:
 - (1) Size or cross section changes.
 - (2) Inlet lead and Conduit intersections.
 - (3) Changes in pipe grade.
 - (4) Street intersections.
 - (5) A maximum spacing of 700 feet measured along the Conduit run.
 - b. Use manholes for existing monolithic-concrete storm sewers at the same locations as above except for intersections of inlet leads unless a manhole is needed to provide maintenance access at those intersections.
 - c. Do not place manholes in driveways or in the street in front of or immediately adjacent to a driveway.
6. Inlets.
 - a. Locate inlets at low points in the gutter.
 - b. Valley gutters across intersections are not permitted.
 - c. Inlet spacing is a function of gutter slope. The minimum gutter slope shall comply with Chapter 10, Street Paving Design Requirements. For minimum gutter slopes, the maximum spacing of inlets shall result from a gutter run of 700 feet from high point in pavement or the adjacent inlet on a continuously graded street section, with a maximum of 1400 feet of pavement draining towards any one inlet location.
 - (1) Residential Development: Maximum spacing of inlets shall result from a gutter run of 700 feet from high point in pavement to the adjacent inlet on a continuously graded street section, with a

- maximum of 1400 feet of pavement draining towards any one inlet location.
- (2) Commercial Development: Maximum spacing of inlets shall result from a gutter run of 400 feet from high point in pavement to the adjacent inlet on a continuously graded street section with a maximum of 600 feet of pavement draining towards any one inlet location.
- d. Use only City of Houston standard inlets.

Table 9.1
STANDARD STORM SEWER INLETS

INLET	APPLICATION	CAPACITY	DWG. NOS.
Type A	Parking Lots/Small Areas	2.5 cfs	02632-01
Type B-B	Residential/Commercial	5.0 cfs	02632-04
Type C	Residential/Commercial	5.0 cfs	02632-06
Type C-1	Commercial	10.0 cfs	02632-06
Type C-2	Commercial	15.0 cfs	02632-06
Type C-2A	Commercial	20.0 cfs	02632-06
Type D	Parking Lots	2.0 cfs	02632-07
Type D-1	Small Areas	2.5 cfs	02632-08
Type E	Roadside ditches	20.0 cfs	02632-09,-10
Type H-2	Residential Commercial	5.0 cfs	02633-01,-02

- e. Do not use beehive grate inlets or other specialty inlets.
- f. Do not use grate top inlets in unlined roadside ditch.
- g. Do not place inlets in the circular portion of cul-de-sac streets unless justification based on special conditions can be provided.
- h. Place inlets at the end of proposed pavement, if drainage will enter or leave pavement.
- i. Do not locate inlets adjacent to esplanade openings.
- j. For new residential development, locate inlets at the center of lots and coordinate drainage system with lot site layout such that inlets are not

located within the driveway between the radius end points as defined by the driveway radius intersection with the curb or edge of pavement.

- k. Place inlets on side streets intersecting major streets, unless justification based on special conditions can be provided.
- l. For private development with internal site drainage, only one connection is permitted to any one inlet, and that connection (lead) shall be made to the back of the inlet. Connection shall not be made to the front face and to the short sides of the inlet unless approved by the City. Design the connection not to exceed the outlet pipe capacity minus either the capacity listed in Table 9.1, Standard Storm Sewer Inlets, or calculated inlet inflow.
- m. For all new construction, convey public or private alleyway drainage to an inlet prior to entering the public street drainage system.

D. Consideration of Overland Flow for the Extreme Event.

- 1. Design Frequency: Design frequency for consideration of overland flow shall consider extreme storm events (100-year storm) which exceed the capacity of the underground storm sewer system resulting in ponding and overland flow from the Development to the primary outlet.
- 2. Design Analysis: An overland flow analysis of the proposed drainage system shall be prepared by the design engineer. The design engineer shall submit supporting calculations, exhibits, and drawings.
 - a. Three analysis methods as presented in Technical Paper No. 101, Simplified 100-year Event Analyses of Storm Sewers and Resultant Water Surface Elevations for Improvement Projects in the City of Houston, Harris County, Texas Region will be acceptable to the City.
 - (1) Method 1: Hydraulic Grade Line (HGL) Analysis
A simplified approach to analyze and control the 100-year water surface elevation (WSEL) can be achieved by designing the storm sewer system for the 2-year frequency storm event; imposing a 100-year frequency storm event on the proposed design; calculating the hydraulic grade for the 100-year frequency event for the proposed design; and adjusting the position of the HGL to not exceed the desired water surface elevation by increasing the size of the proposed storm sewer for selective reaches.
 - (2) Method 2: $Q_t = Q_o + Q_c$
where Q_t is the total flow conveyed,
 Q_o is the overland flow component, and
 Q_c is the calculated flow in the conduit for the 2-year design

event.

The overland flow component (Q_o) is computed by applying Manning's Equation to calculate the flow across the critical street cross-section along the right of way. This method accounts for flow in the storm sewer and overland flow across the street crest, but does not account for street ponding or storage.

(3) Method 3: $Q_t = Q_o + Q_c + \Delta S/T$

where Q_t , Q_o , and Q_c are as defined above, and $\Delta S/T$ is the change in storage volume relative to time provided in the streets and adjacent area upstream of the point of interest being analyzed.

This method uses a volumetric calculation based on a 100-year frequency storm event with a duration of 3-hours for developments less than 200 acre and 6-hours duration for developments over 200 acres. The Soil Conservation Service, TR-20 method is used to set a peak triangular hydrograph shape. This method accounts for flow in the storm sewer, overland flow across the street crest, and storage within the street and adjacent area.

b. Analysis using the U.S. Environmental Protection Agency's Storm Water Management Model (SWMM) will be acceptable to the City.

3. Relationship of Structures to Street: All structures shall be higher than the highest level of ponding anticipated resulting from the extreme event analysis.
4. The parameters stated below are independent measures that shall be evaluated for each project. The limiting parameter will depend on project-specific conditions, and the most restrictive condition (the lowest ponded water elevation) shall govern.
 - a. Streets shall be designed so that consecutive high points in the street will provide for a gravity flow of drainage to the ultimate outlet.
 - b. The maximum depth of ponding at high points shall be 6 inches above top of curb.
 - c. The maximum depth of ponding at low points shall be 18 inches above top of curb.
 - d. Provide a minimum 20-foot easement to accommodate sheet flow that is routed between lots or across reserve tracts in accordance with Section 5.07.C of the City of Houston Infrastructure Design Manual. Fence lines and other improvements shall not be constructed on or across dedicated drainage easements.

- e. A drawing(s) shall be provided to delineate extreme event flow direction through a proposed Development and how this flow is discharged to the primary drainage outlet. The drawing(s) shall show a profile of the roadway (or overland flow path) from the upper reach of the drainage area to the primary drainage outlet. The drawing(s) shall be exaggerated vertical scale and shall include roadway profile at the gutter, ground profile at the right-of-way, and the hydraulic gradient for the extreme event (100-year storm), or an alternative equivalent drawing accepted by the City.
- f. In areas where ponding occurs and no Sheet Flow path exists, then a calculation shall be provided showing that run-off from the 100-year event can be conveyed and remain in compliance with the other requirements of this paragraph.
- g. Maximum Ponding Elevation
 - (1) The maximum ponding elevation for the 100-year event at any point along the street shall not be higher than the natural ground elevation at the right-of-way line. Where existing topographic conditions, project location within a special flood hazard area, and/or other site conditions preclude achieving this objective, the City will waive this requirement upon submittal of documentation and analysis prepared, signed, and sealed by a professional engineer, registered in the State of Texas. Analysis shall demonstrate that structural flooding will not occur.
 - (2) For new subdivisions the ponding elevations shall be no higher than 12 inches below the proposed finished slab elevations, or, if the proposed finished slab elevations are less than 12 inches above the ground elevations at the right-of-way, the ponding elevations shall be no higher than the ground elevations at the right-of-way.

E. Design of Open Channels.

- 1. Design Frequency.
 - a. Open channels shall be designed according to methods described in the HCFCD Criteria Manual.
 - b. Design standards for channel construction shall follow the requirements specified in the HCFCD Criteria Manual.
 - c. Design standards for outfalls into channels shall conform to those in the HCFCD Criteria Manual.
- 2. Determination of Water Surface Elevation.

- a. Water surface elevations shall be calculated using Manning's Equation and the Continuity Equation.
 - b. For the Design Storm Event, the water surface shall be calculated to remain within banks.
- 3. Design of Culverts.
 - a. Head losses in culverts shall conform to TxDOT Hydraulics Manual, Chapter 4, Culverts.
 - b. Corrugated metal pipe will only be approved for railroad crossings.
- F. Design of Roadside Ditches.
 - 1. Design Frequency.
 - a. Roadside ditch design is permissible only for single family residential lots or commercial areas equal to or larger than 0.5 acres.
 - b. The Design Storm Event for the roadside ditches shall be a minimum of 2-year rainfall.
 - c. Design capacity for a roadside ditch shall be to a minimum of 0.5 feet below the edge of pavement or 0.5 feet below the natural ground at right-of-way line, whichever is lower.
 - d. The design must include an extreme event analysis to indicate that structures will not be flooded, and maximum ponding elevation for the extreme event complies with Paragraph 9.05.D.3.
 - 2. Velocity Considerations.
 - a. For grass-lined sections, the maximum design velocity shall be 3.0 feet per second during the design event.
 - b. A grass-lined or unimproved roadside ditch shall have side slopes no steeper than three horizontal to one vertical (3:1), or as soil conditions will permit.
 - c. Minimum grades for roadside ditches shall be 0.1-foot per 100 feet.
 - d. Calculation of velocity will use a Manning's roughness coefficient (n) of 0.045 for earthen sections and 0.025 for ditches with paved inverts.

- e. Use erosion control methods acceptable to the City when design velocities are expected to be greater than 3 feet per second.
- 3. Culverts.
 - a. Culverts will be placed at all driveway and roadway crossings, and other locations where appropriate.
 - b. Culverts will be designed assuming inlet control.
 - c. Roadside culverts are to be sized based on drainage area. The minimum culvert size shall be 24 inches unless the option for multiple smaller size culverts is approved by the City Engineer. When requested, calculations shall be provided for review. Culvert shall be placed to be a minimum of 4 inches and no more than 8 inches below the ditch flow line. Existing roadside ditch on both sides of the proposed culvert shall be regraded for positive drainage to the nearest intersection or up to 500 linear feet whichever is smaller. In the ETJ, the Regulations for Harris, County, Texas for the Construction of Driveways and/or Culverts on County Easements and Rights-of-Way shall govern.
 - d. Cross open channels with roadside culverts no smaller than 24 inches inside diameter or equivalent. The size of culvert used shall not create a head loss of 0.20 feet greater than the normal water surface profile without the culvert.
 - e. Stormwater discharging from a ditch into a storm sewer system must be received by use of an appropriate structure (i.e., stubs with ring grates or Type E inlets).
- 4. Invert Protection.
 - a. Ditch invert protection shall be used when velocities exceed 3 feet per second.
 - b. Ditch invert protection will be used at the upstream and downstream ends of all culverts.
- 5. Depth and Size Limitations.
 - a. Maximum depth shall not exceed 4 feet from adjacent edge of pavement.
 - b. Roadside ditch bottoms shall be at least 2 feet wide, unless design analysis will support a narrower width.

- c. Ditches in adjoining and parallel easements shall have top of bank not less than 2 feet from the outside easement line.
- G. Design of Outfalls: Outfall design shall conform to HCFCD Standards.
- H. Stormwater Detention.
 - 1. The intention of stormwater detention is to mitigate the effect of the New Development, Redevelopment, or In-fill Development on an existing drainage system. Stormwater detention volume is based on increased impervious cover and is calculated at the minimum rates set forth in Paragraph 9.05.H.3.
 - 2. Application of Detention.
 - a. The use of on-site detention is required for all Developments within the City and for new or expanding utility districts within the City's ETJ. Detention will not be required if the City has developed detention capacity for a drainage watershed, and/or infrastructure improvements, to serve the drainage watershed in compliance with the requirements of this Chapter. Under these conditions, the City will consider a funding contribution in lieu of on-site detention volume constructed by the owner.
 - b. If New Development, Redevelopment, or In-fill Development drains directly into a channel maintained by HCFCD, then HCFCD criteria prevails. If New Development, Redevelopment or In-fill Development drains directly to a roadside ditch, drainage ditch or storm sewer maintained by Harris County then the criteria in Regulations of Harris County, Texas for the Approval and Acceptance of Infrastructure governs; however, for all cases of multiple regulatory jurisdiction, Paragraph 9.02.G takes precedence.
 - c. If the drainage system outfalls directly into a channel maintained by HCFCD, and the requirements of HCFCD include payment of an impact fee, then no further impact fee will be required by the City.
 - d. If Redevelopment occurs without increasing the overall impervious character of the site, then no detention will be required by the City.
 - e. A waiver of detention requirements may be requested if the following conditions are satisfied:
 - (1) Development is located in an area determined by the City to not need detention due to the geographic location in the watershed, the Development's proximity to regional facilities, or the capacity of the receiving outfall facilities. Such conclusion by the City

shall be supported by submittal of a Hydraulic Report as described in Paragraph 9.05.H.2.e(2).

- (2) Hydraulic Report: Submit a hydraulic analysis prepared, signed, and sealed by a professional engineer, registered in the state of Texas, to demonstrate compliance with the conditions stated in this Chapter. The hydraulic analysis shall consider (1) the current developed condition of the watershed of the stormwater conveyance system, and (2) the fully developed condition of the watershed. The probable land use for the fully developed condition will be determined by the design engineer for review and approval by the City. The hydraulic analysis shall demonstrate no negative impact to upstream or downstream conditions and shall demonstrate that a positive impact will be achieved (reduced flood crest) due to the exemption.

3. Calculation of Detention Volume.

- a. Detention volume for Development areas is calculated on the basis of the amount of area of increased impervious cover.
- b. Areas less than 1 acre: Detention will be required at a rate of 0.20 acre feet per acre of increased impervious cover. The subdividing of larger tracts into smaller tracts of 1.0 acre and less will require the detention volume of 0.5 acre-feet per acre of increased impervious cover. Single family residential tracts of 15,000 square feet in area or less are exempt from detention. This exemption does not apply if more than one dwelling unit is located on the tract.
- c. Areas between 1 acre and 50 acres: Detention will be required at a rate of 0.50 acre-feet per acre of increased impervious cover.
- d. Areas greater than 50 acres: Reference HCFCD Criteria Manual.
- e. Private parking areas, private streets, and private storm sewers may be used for detention provided the maximum depth of ponding does not exceed 9 inches directly over the inlet, and paved parking areas are provided with signage stating that the area is subject to flooding during rainfall events.
- f. Private transport truck only parking may be used for detention provided the maximum depth of flooding does not exceed 15 inches directly above the inlet and signage is provided stating that the area is subject to flooding during rainfall events.

4. Calculation of Outlet Size.

- a. Detention pond discharge pipe into an existing storm sewer line or existing City of Houston ditch:
 - (1) Maximum pool elevation at or below the design hydraulic grade at the drainage system outfall - The discharge line shall be sized for the Design Storm with the discharge pipe flowing full. The pond will float on the drainage system to provide maximum benefit.
 - (2) Maximum pool elevation at or above the hydraulic grade at the drainage system outfall - Provide a reducer or restrictor pipe to be constructed inside the discharge line. The discharge line shall be sized for the Design Storm with the discharge pipe flowing full.
- b. Reducer or Restrictor Pipes shall be sized as follows:
 - (1) Allowable Discharge Rate – Use the lowest of the discharge rates described below:
 - (a) Restrictor pipes will provide a combination of low level and high level controlled release from the detention basin. The low level restrictor pipe (primary orifice) shall be sized to provide a release rate of 0.5 CFS/acre when the detention basin water depth reaches 25% of full basin depth. The low level restrictor pipe (primary orifice) shall be located at the bottom of the basin to provide complete drainage of the pond. The high level restrictor pipe (secondary orifice) shall be sized to provide a combined release rate (from the primary orifice and secondary orifice) of 2.0 CFS/acre at full basin depth. The high level restrictor (secondary orifice) shall begin releasing flow when detention basin water depth reaches 75% of full basin depth. The combined rate of 2.0 CFS/acre is the approximate discharge from an undeveloped tract for the 100-year storm.
 - (b) Flow discharged to the storm drain shall not exceed the proportional amount of pipe capacity allocated to the Development. The proportional amount of pipe capacity allocated to the Development shall be determined by the ratio of the area (acres) of the Development (in storm drain watershed) divided by the total drainage area (acres) of the storm drain multiplied by the capacity of the storm drain.

- (2) Use the following equations to calculate the required outflow orifice:

$$Q = CA \sqrt{2g} \sqrt{h}$$

$$D = Q^{1/2} / (2.25 h^{1/4})$$

Where:

Q = outflow discharge (cfs)
 C = coefficient of discharge
 = 0.8 for short segment of pipe
 = 0.6 for opening in plates, standpipes, or concrete walls
 A = orifice area (square feet)
 g = gravitational factor (32.2)
 h = head, water surface differential (feet)
 D = orifice diameter (feet)

- (3) Restrictor shall be either of the required diameter or of the equivalent cross-sectional area. The orifice diameter D shall be a minimum of 0.5 feet.

- c. In addition to a pipe outlet, the detention basin shall be provided with a gravity spillway that will protect structures from flooding should the detention basin be overtopped.

5. Ownership and Easements.

a. Private Facilities:

- (1) Pump discharges into a roadside ditch requires the submittal of pump specifications on the design drawings.
- (2) The City reserves the right to prohibit the use of pump discharges where their use may aggravate flooding in the public right-of-way.
- (3) Responsibility for maintenance of the detention facility must be indicated by letter submitted to the City as part of the design review.
- (4) All private properties being served have drainage access to the pond. Dedicated easements may be required.
- (5) No public properties drain into the detention area.
- (6) A private maintenance agreement is provided when multiple tracts are being served.

b. Public Facilities:

- (1) Facilities will only be accepted for maintenance by the City within the City limits in cases where public drainage is being provided.
- (2) The City requires a maintenance work area of 30-foot width surrounding the extent of the detention area. Public rights-of-

way or permanent access easements may be included as a portion of this 30-foot width.

- (3) A dedication of easement shall be provided by plat or by separate instrument.
- (4) Proper dedication of public access to the detention pond must be shown on the plat or by separate instrument. This includes permanent access easements with overlapping public utility easements.
- (5) Backslope drainage systems are required where the natural ground slopes towards the drainage basin. A basin that is within 30 feet of a parking lot or roadway with berms that drain away from the basin does not require a backslope swale. Comply with criteria provided in HCFCF Criteria Manual.

9.06 EASEMENT AND RIGHTS-OF-WAY

- A. Storm sewer easement and right-of-way requirements are described in Chapter 5, Easement Requirements.

9.07 SUBMITTALS

- A. Preliminary Submittals - Submittal, for review and comment, of one-line drawings is recommended and may be required as part of the platting process. One-line drawings should include:
 1. Approximate definition of lots and street patterns.
 2. The approximate drainage areas for each system.
 3. A definition of the proposed drainage system by single line.
 4. The proposed pipe diameters.
 5. Any proposed drainage easements.
 6. Floodplain information, including floodplain boundary, if any; FEMA map number, effective map date and zone.
- B. Final Design - Submit the following for approval:
 1. Copies of any documents which show approval of exceptions to the City design criteria.
 2. Design calculations for time of concentration, storm line sizes and grades, and for detention facilities, if any.

3. Design calculations for the Hydraulic Grade Line of each line or ditch, and for detention facilities, if any.
 4. Drainage Area Map with the following information:
 - a. Existing contour map.
 - b. Drainage area and sub-drainage area boundaries.
 - c. Drainage area (acres) and flow quantity (cfs) draining to each inlet and each pipe segment from manhole to manhole.
 - d. Extreme event (100-year) Sheet Flow direction.
 - e. Existing condition and developed condition Sheet Flow direction for the surrounding properties.
 5. Plan and profile sheets showing stormwater design (public facilities only).
 6. Projects located within a floodplain boundary or within a floodplain management area shall:
 - a. Show the floodplain boundary or floodplain area, as appropriate, on the one-line drawing or Drainage Area Map.
 - b. Comply with all applicable submittal requirements of Chapter 19, Code of Ordinances.
 7. Profile drawing of roadway (or overland flow path) with exaggerated vertical scale from the upper reach of drainage area to the primary drainage outlet. Show roadway profile at gutter, ground profile at the public right-of-way, and hydraulic gradient for the 100-year extreme event; or an alternative equivalent drawing accepted by the City.
 8. Calculation for proportional amount of pipe capacity allocated to the Development along with the drainage area map used for these calculations.
- C. Signature Stage - Submit the following for approval:
1. Review prints.
 2. Original drawings.
 3. Stormwater detention maintenance agreement letters.
 4. Drainage Area Map with the following information:

- a. Existing contour map.
- b. Drainage area and sub-drainage area boundaries.
- c. Drainage area (acres) and flow quantity (cfs) draining to each inlet and each pipe segment from manhole to manhole.
- d. Extreme event (100-year) Sheet Flow direction.
- e. Existing condition and developed condition Sheet Flow direction for the surrounding properties.

- 5. Profile drawing as specified in Paragraph 9.07.B.7.

9.08 QUALITY ASSURANCE

- A. Prepare calculations and design drawings under the supervision of a Professional Engineer trained and licensed under the disciplines required by the project scope. The final design drawings and all design calculations must be sealed, signed, and dated by the Professional Engineer responsible for the development of the drawings.

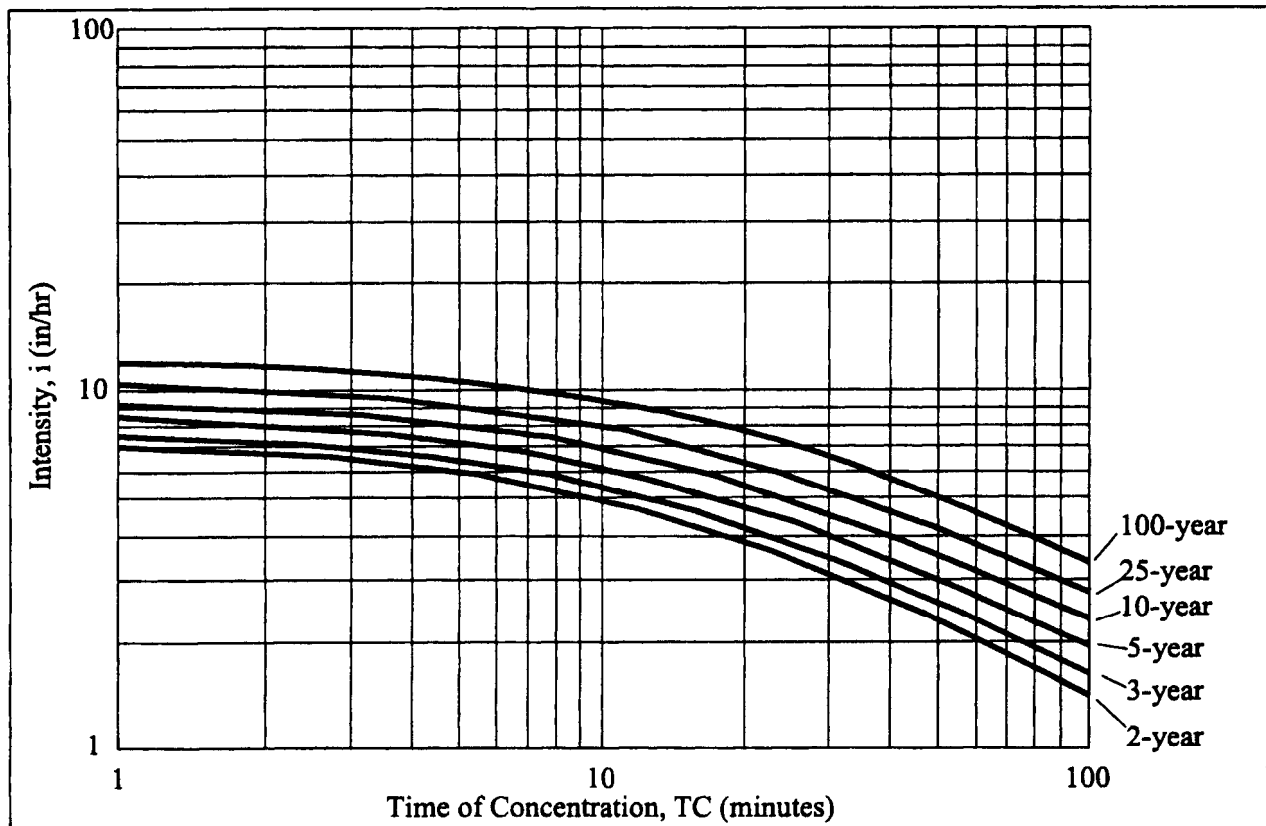
9.09 DESIGN ANALYSIS

- A. Projects shall be tied to National Geodetic Survey (NGS) datum adjustment which matches the Federal Emergency Management Agency (FEMA) rate maps or the most current NGS datum which matches the FEMA rate maps. In the event GPS surveying is used to establish bench marks, at least two references to bench marks relating to the FEMA rate maps shall be identified. Equations may be used to translate other datum adjustments to the required adjustment.
- B. Drawing sets shall include a Drainage Area Map, which will contain calculations of flow by the rational method.
- C. Drainage systems for curb-and-gutter pavements shall be underground closed Conduits; individual residential lot drainage is exempt. Drainage systems for pavements without curb and gutter shall be roadside open-ditch sections.

END OF CHAPTER

FIGURE 9.1

City of Houston IDF Curves
Intensity vs. Time of Concentration vs Rainfall Frequency
Source: Hydro 35/TP-40



$$i = \frac{b}{(d+TC)^e}$$

$$TC = 10A^{0.1761} + 15$$

A = area in acres

Rainfall Frequency	b	d	e
2-year	75.01	16.2	0.8315
3-year	77.27	17.1	0.8075
5-year	84.14	17.8	0.7881
10-year	93.53	18.9	0.7742
25-year	115.9	21.2	0.7808
100-year	125.4	21.8	0.7500

Figure 9.2
City of Houston Storm Sewer Calculation Form

Project: _____
 Job No: _____
 System: _____
 By: _____
 Checked by: _____

[illegible]

Figure 9.3
City of Houston Roadside Ditch Worksheet

Project: _____
 Job No: _____
 System: _____
 By: _____
 Checked by: _____

[illegible]

City of Houston

Design Manual

Chapter 10

STREET PAVING DESIGN REQUIREMENTS

Chapter 10

STREET PAVING DESIGN REQUIREMENTS

10.01 CHAPTER INCLUDES

- A. Geometric design guidelines for streets, criteria for street paving, and standard paving notes for drawings.

10.02 REFERENCES

- A. Refer to the list of references in Chapter 1, General Requirements.
- B. AASHTO - American Association of State Highway and Transportation Officials
- C. ASTM - American Society for Testing and Materials

10.03 DEFINITIONS

- A. Geotechnical Engineer - An engineer certified by the American Association for Laboratory Accreditation (A2LA).
- B. HMAC - Hot-mix asphaltic concrete
- C. Curb-and-gutter Sections - Full width concrete pavement with doweled on 6-inch curbs or monolithic curb-and-gutter sections for asphaltic concrete pavement. Curb-and-gutter sections require inlets and underground storm sewers.
- D. Roadside Ditch Sections - Ditch sections adjacent to either full width reinforced concrete pavement or asphaltic concrete pavement. Roadside ditch sections do not require underground storm sewers; however, the ditch sections must be designed to accommodate storm runoff.
- E. The following definition is quoted from the City of Houston Subdivisions, Developments and Platting Requirements, included in Chapter 42 of the Code of Ordinances No. 1999-262.
“*Type 1 permanent access easement* shall mean a permanent access easement at least 50 feet in width that is designed and constructed like a public street in accordance with the design manual and contains one or more public utilities in an unpaved portion of the easement.”
- F. The following definition is quoted from the City of Houston Subdivisions, Developments and Platting Requirements, included in Chapter 42 of the Code of Ordinances No. 1999-262.
“*Type 2 permanent access easement* shall mean a permanent access easement at least 28 feet

in width that is designed and constructed like a private street serving a development that has no public utilities other than a public water line connected only to one or more fire hydrants that provides no domestic water services.”

1. Include permanent access easement as shown in Figure 10.8, Type 2 Permanent Access Easement - Terminus Standard.

10.04 DESIGN REQUIREMENTS

The following design requirements are applicable to pavements within City street rights-of-way:

- A. Width Requirements for Roadways: Geometric Design Guidelines for Subdivision Streets included with this Chapter for the Divided Roadway Cross Sections - Urban, and Undivided Roadway Cross Sections - Urban.
- B. Minimum Thickness and Reinforcement Requirements for Concrete Pavement. The following requirements are the minimum allowable. Pavement thickness and reinforcement shall be designed by a Professional Engineer based on a current soils analysis, roadway use, traffic loadings, and life span of proposed pavement.
 1. For pavement widths less than or equal to 27 feet face-to-face (F/F) of curb:
 - a. Minimum concrete slab thickness shall be 6 inches with $f'_c = 3000$ psi and reinforcement with $f_y = 60,000$ psi. Refer to Standard Details for reinforcement drawings.
 - b. Minimum stabilized subgrade thickness shall be 6 inches.
 2. For major thoroughfares:
 - a. Minimum concrete slab thickness shall be 8 inches with $f'_c = 3000$ psi and reinforcement with $f_y = 60,000$ psi. Refer to Standard Details for reinforcement drawings.
 - b. Minimum stabilized subgrade thickness shall be 6 inches.
 3. For streets other than described in Paragraphs 10.04B.1 and 10.04B.2 (i.e., streets greater than 27 feet F/F of curb and not major thoroughfares):
 - a. Minimum concrete slab thickness shall be 7 inches with $f'_c = 3000$ psi and reinforcement with $f_y = 60,000$ psi. Refer to Standard Details for reinforcement

drawings.

- b. Minimum stabilized subgrade thickness shall be 6 inches.
- C. Minimum Thickness of Asphaltic Concrete Pavement: Minimum thickness of HMAC surfacing and flexible base shall be as shown on Standard Details.
- D. Subgrade Treatment: Treatment of subgrade shall be determined by a geotechnical engineer. The geotechnical engineer shall base depth of subgrade stabilization on structural number (SN) in conjunction with flexible pavement thickness design.
- E. Requirements for Intersections, Turnouts, and Transitions:
- 1. At a T-intersection with a street that has not been improved to its ultimate width, concrete pavement shall be stopped either at the right-of-way line or the end of the curb return, whichever would require less concrete removal at a future date.
 - 2. For roadway turnouts placed at an existing cross street intersection, the turnout should be designed to fit the ultimate pavement width of the intersecting cross street and then transitioned to the existing roadway.
 - 3. The usual transition length for meeting a roadside ditch street is 50 feet for street widths less than or equal to 27 feet F/F of curb; 75 feet for 36 feet F/F of curb; and 100 feet for 40 feet F/F of curb.
 - a. Transition sections for streets other than concrete shall consist of flexible base paving. See Standard Detail 02741-01 - Hot-Mix Asphaltic Concrete Pavement Details.
 - b. Transitions for concrete streets shall consist of concrete and equal the existing pavement thickness with a minimum thickness of 6 inches. See Standard Detail 02751-01 - Concrete Pavement Details.
 - 4. When meeting existing concrete streets at right angles, the existing street should be saw cut in a V-shape extending from the curb returns to a point where the centerline of the proposed pavement intersects the quarter point of the existing concrete street to create a crowned intersection. In the event this construction creates a situation in which traffic on the existing street, at design speed, will bottom out when crossing the proposed street intersection, a special design will be allowed to eliminate this potentially dangerous condition.

F. Requirements for Roadway Ditches.

1. Ditch capacity shall be designed to handle storm water runoff in accordance with Chapter 9, Storm Water Design Requirements.
2. Minimum ditch grades and maximum ditch side slopes shall conform to the requirements of Chapter 9, Storm Water Design Requirements.
3. Culverts shall be designed to accommodate ditch flow and shall be constructed of reinforced concrete. Wall thickness shall be Wall B as given in ASTM C 76. Refer to Chapter 9, 9.05F.3.c.

G. Requirements for Roadways with Curb and Gutter Sections.

1. Inlet spacing.
 - a. City Funded Projects: Spacing shall be determined by Manning's Formula using parameters (e.g., limits of pavement flooding allowed, etc.) as specified by the City Engineer.
 - b. Non-City Funded Projects: The maximum allowable curb run to an inlet shall be as provided in Chapter 9, 9.05C.6.c.
2. Minimum grade line shall be 0.30 percent.
3. Minimum grade line shall be one percent for radii of 35 feet or less around intersection turnouts. Grades for larger radii shall be determined on an individual basis.
4. Vertical curves shall be installed when the algebraic difference in grades exceed one percent. Elevations shall be shown at 10-foot intervals through vertical curves. Maintain a minimum of 0.03-foot elevation change at 10-foot intervals by altering calculated elevations.
5. Radii around cul-de-sacs shall be 42 feet for single family areas and 50 feet for all others.
6. When a curb-and-gutter street intersects a drainage ditch, the gutter elevation shall be above the designed water surface elevation of the ditch.
7. Minimum grade line around a cul-de-sac shall be 0.70 percent.
8. Major thoroughfares shall be superelevated in accordance with recommendations of AASHTO.

9. Cross slopes for pavement shall be as shown on Standard Details. The minimum cross slope for left-turn lanes and esplanade openings shall be 1/8 inch per foot.
10. Minimum grade line around the longest radius on an L-type street shall be 0.40 percent.
11. When meeting an existing curb-and-gutter street, top-of-curb elevations shall be designed to meet an elevation 6 inches above the existing gutter. At existing inlets, top-of-curb elevations shall be designed to match existing top-of-curb elevations.
12. When the curb grades are not established below the natural ground, fill lines shall be shown on the drawings and shall be of sufficient height to ensure a minimum of 3/8 inch per foot transverse slope toward the curb from the property line between a point 2 feet outside the right-of-way line and the top of curb. If this type fill is required and the pavement is adjacent to a nonparticipating property owner, fill easements shall be obtained, filed, and a copy of the easements shall accompany the final drawings. Construction of this nature will require back-slope drainage design to prevent trapping storm runoff.
13. The maximum desirable tangent grade to vertical curves at railroad crossings is 8 percent for local streets and 3.5 percent for major thoroughfares.
14. Top-of-curb grades for the outside lanes shall be labeled except at railroad crossings where gutter grades shall be labeled. Centerline grades are acceptable for streets with roadside ditch sections.
15. Roadway grades at railroad crossings shall be zero percent from centerline of the track to 10 feet either side of the track's centerline, and should not cause a drop of more than 6 inches from the top-of-rail elevation at a distance of 30 feet either side of the track's centerline.
16. For concrete roadways, the roadway shall terminate at a railroad header, 6 feet from the centerline of the track and the roadway cross slope shall be zero from the railroad header to 4 feet before the railroad header.

H. Requirements for Inlets with Curb-and-Gutter Sections.

1. City-approved inlets shall be used on all curb-and-gutter sections within the city limits and in the ETJ.
2. Keep proposed inlets away from esplanade openings and out of major thoroughfare intersections. For intersections between a major thoroughfare and a minor street, locate inlets at the end of return (E/R) of the side street.

3. Inlets shall be placed at the end of pavement in order to eliminate drainage from the pavement gutter into a roadside ditch.
4. When curb-and-gutter streets connect to roadside ditch streets, place inlets at end of curb-and-gutter streets with reinforced concrete pipe stubs with ring grates to collect ditch storm water. See Standard Detail 02632-11 - Side Street Ditch Reception.
5. Use only City standard cast iron grates for curb inlets.

I. Requirements for Curbs, Sidewalks, and Driveways.

1. Standard curb height is 6 inches.
2. At railroad track approaches, decrease curbs from 6 inches to zero inches in 2 feet at a distance of 10 feet from the nearest track centerline.
3. Reinforced concrete sidewalks and driveways shall be in accordance with City Standard Details.
4. Reinforced concrete sidewalks in esplanades - Reinforced concrete sidewalks, 6 inches thick, shall be constructed in esplanades when curbs are 10 feet F/F of curb and less in width with a minimum length of 6 feet measured from the face of curb of the esplanade nose. Reinforced concrete sidewalks in esplanades shall be colored black for concrete roadways and uncolored for asphaltic concrete roadways.

J. Requirements for Thoroughfares.

1. When the full section of a thoroughfare is located within the city limits and is dedicated on a final plat, the esplanade and all lanes of the thoroughfare shall be constructed at the time of initial construction of the roadway.
2. If approved by the City Engineer, lanes contained within a plat, left-turn lanes and the esplanade to the centerline of the right-of-way shall be constructed at the time of initial construction of the roadway when only one side of a thoroughfare is located on a final plat. The remaining lanes, left-turn lanes and esplanade shall be constructed at the time the final plat containing the opposite side of a half constructed thoroughfare is approved.
3. Permanent barricades, conforming to the requirements of the Texas Manual of Uniform Traffic Control Devices, shall be constructed at the termination of lanes on partially constructed thoroughfares. The barricades shall contain a sign reading FUTURE ROADWAY EXTENSION.

K. Requirements for Miscellaneous Items.

1. The type and depth of subgrade treatment shall be as determined by the geotechnical engineer.
2. For proposed driveways, call out centerline stations, widths, and radii.
3. Treat private streets as if they were driveways. See Standard Details for drawings of private street intersections and of driveways.
4. Paving headers shall be placed at the end of concrete pavements.
5. Concrete to be removed shall be removed either to an existing joint or a sawed joint. The groove of the sawed joint shall be cut to a minimum depth of 2 inches along the line designated by the Professional Engineer.
6. Determine minimum vertical curve lengths based on AASHTO design criteria (minimum 3 times design speed) using a minimum design speed of 45 miles per hour for thoroughfares and collector streets and 35 mph for residential streets.
7. Standard City barricades shall be placed at the end of dead-end streets not terminating in a cul-de-sac.
8. If discharging storm water into a HCFCD ditch, HCFCD approval must be obtained before City approval.
9. A letter of agreement between the City and pipeline company approving the construction plan crossing is required when paving is placed over a transmission pipeline.
10. When meeting existing concrete pavement, horizontal dowels shall be used if no exposed reinforcing steel exists. Horizontal dowels shall be Grade 60 bars, 24 inches long, drilled and embedded 12 inches into the center of the existing slab with PO ROC, or approved equal. Dowels shall be 12 inches center-to-center, unless otherwise specified.
11. When concrete is removed for connection with proposed concrete pavement, the pavement shall be saw cut and existing concrete removed to expose a minimum of 15 inches of reinforcing steel. If no reinforcing steel exists, use horizontal dowels per Paragraph 10.04 K.10.
12. Adjust existing manhole frames and covers within the limits of the proposed pavement to meet the proposed top-of-slab elevation.

13. Adjust existing manhole frames and covers outside the limits of the pavement to conform to the final grading plan.
14. Type 1 permanent access easement shall be designed according to public street standards as identified in this chapter.
15. Type 2 permanent access easement shall be designed to provide a turn-around in accordance with the geometric design guidelines in this chapter.

10.05 QUALITY ASSURANCE

- A. Final design drawings and specifications shall be prepared by or under the supervision of a Professional Engineer, and all documents shall be sealed, dated, and signed by the responsible Professional Engineer.
- B. Geotechnical work shall be performed by or under the supervision of a Professional Engineer. All reports and documents shall be sealed, dated, and signed by the responsible Professional Engineer.

10.06 DESIGN ANALYSIS

- A. Pavement thickness and reinforcement shall be designed by a Professional Engineer based on a current soils analysis, roadway use, traffic loadings, and life span of proposed pavement.
- B. The number and location of storm sewer inlets shall be designed to accommodate storm water runoff. A graphical plot and calculations of the hydraulic gradient shall be furnished by the design engineer. The hydraulic gradient shall be in accordance with Chapter 9, Storm Water Design Requirements.
- C. Roadside ditch drainage and culverts shall be designed in accordance with Chapter 9, Storm Water Design Requirements.

10.07 DRAWINGS

- A. Construction drawings shall be prepared in compliance with Chapter 3, Graphic Requirements.

10.08 GEOMETRIC DESIGN GUIDELINES

- A. Refer to Geometric Design Guidelines for Subdivision Streets, Harris County and City of Houston provided at the end of this chapter.

END OF CHAPTER

GEOMETRIC DESIGN GUIDELINES FOR SUBDIVISION STREETS

HARRIS COUNTY
CITY OF HOUSTON

THE GUIDELINES IN THIS DOCUMENT ARE HEREBY APPROVED
AS BASIC REQUIREMENTS FOR FUTURE STREET PLANNING
AND DEVELOPMENT - JUNE, 2002.



DIRECTOR
DEPARTMENT OF PUBLIC WORKS &
ENGINEERING, CITY OF HOUSTON



EXECUTIVE DIRECTOR
PUBLIC INFRASTRUCTURE DEPARTMENT,
HARRIS COUNTY



DEPUTY DIRECTOR
DEPARTMENT OF PUBLIC WORKS &
ENGINEERING, CITY OF HOUSTON



DIRECTOR
DEPARTMENT OF PLANNING & DEVELOPMENT
CITY OF HOUSTON

THE GUIDELINES PRESENTED IN THIS DOCUMENT INCLUDE THE MOST OFTEN REQUESTED INFORMATION REGARDING GEOMETRIC DESIGN OF SUBDIVISION STREETS. DESIGNATED MAJOR THOROUGHFARES¹, AND COLLECTOR STREETS¹ WITHIN SUBDIVISIONS, SHALL BE CONSIDERED FOR SPECIAL DESIGN FEATURES AND MAY REQUIRE HIGHER DESIGN CRITERIA THAN SHOWN HEREIN. ALSO, DESIGN FEATURES NOT SHOWN IN THESE GUIDELINES SHOULD BE CONSIDERED SPECIAL DESIGN FEATURES.

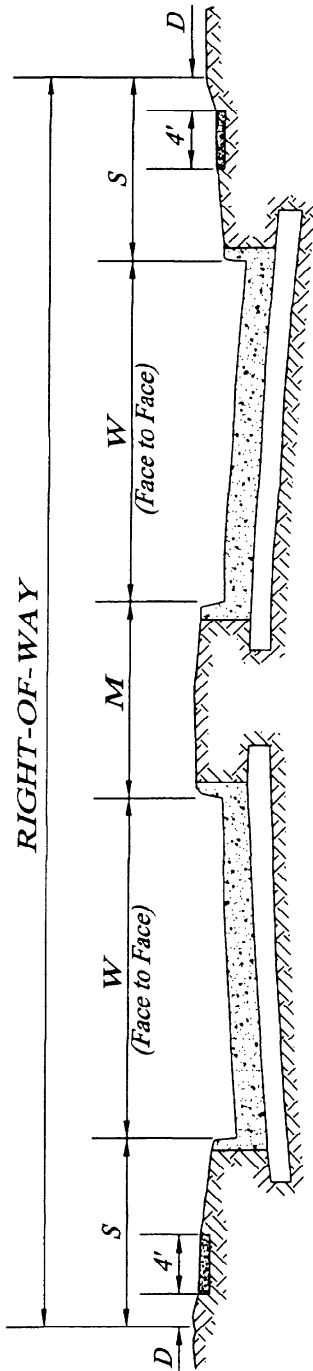
IT IS ADVISABLE TO CONSULT WITH THE APROPRIATE AGENCIES AND REVIEW THE MOST RECENT EDITION OF THE FOLLOWING PUBLICATIONS TO DETERMINE ADEQUATE THOROUGHFARE REQUIREMENTS AND SPECIAL DESIGN FEATURES.

- RECOMMENDED GUIDELINES FOR SUBDIVISION STREETS, INSTITUTE OF TRANSPORTATION ENGINEERS.
- GUIDELINES FOR URBAN MAJOR STREETS DESIGN, INSTITUTE OF TRANSPORTATION ENGINEERS.
- A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS, AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS.
- TEXAS MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (TMUTCD), TEXAS DEPARTMENT OF TRANSPORTATION.

¹DESIGNATED ROADWAY APPEARING ON THE MAJOR THOROUGHFARE AND FREEWAY PLAN, HOUSTON CITY PLANNING COMMISSION.

FIGURE 10.1

DIVIDED ROADWAY CROSS SECTION-URBAN



NOTE: This design shows presence of typical curb and gutter and does not imply or recommend drainage design

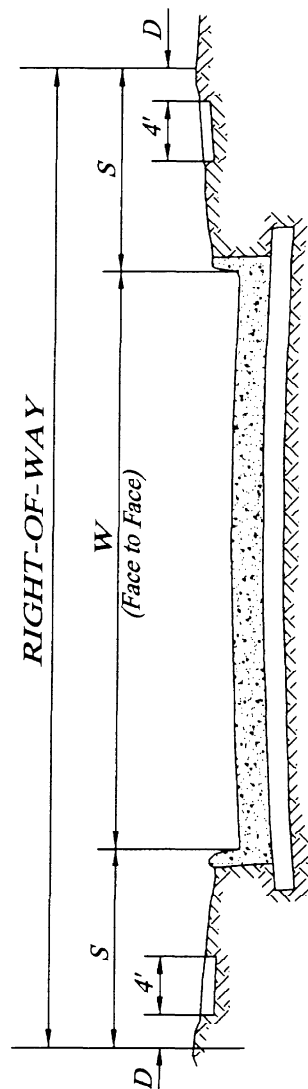
DIVIDED ROADWAY DIMENSIONS (In Feet)

R.O.W. (1)	80	90	100	(2)
W	24	24	24	33
M	14	22	32	14
S	9	10	10	10
D	2	2	2	2

(1) Any right-of-way dimensions different from those shown shall require special geometric design as determined by City Engineer.
(2) Ultimate design

FIGURE 10.2

UNDIVIDED ROADWAY CROSS SECTION-URBAN



NOTE: This design shows presence of typical curb and gutter and does not imply or recommend drainage design.

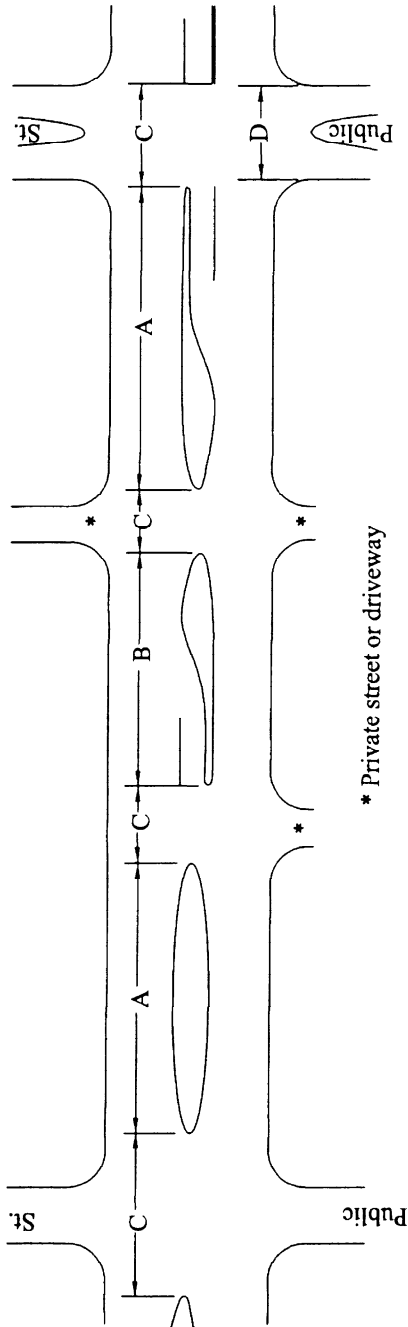
UNDIVIDED ROADWAY DIMENSIONS (In Feet)

ABUTTING LAND USE	SINGLE FAMILY				ALL OTHER	
	(1) (5) STANDARD LOT		HIGH DENSITY LOT (2)		APT./ (3) COMM.	MAJOR (4)
R.O.W.	50	60	55	60	60	60
W	27	27	36	36	40	44
S	11.5	16.5	9.5	12	10	8
D	2	2	2	2	2	1

- (1) Standard lot: Lot widths 40 feet or greater along street right-of-way line.
- (2) High density lot: Lot widths less than 40 feet along street right-of-way line.
- (3) Apartment/commercial: Any property use other than single family.
- (4) Major: Any roadway designated as a major arterial on the major thoroughfare and freeway plan.
- (5) Width: 24' permissible for cul-de-sac length $\leq 350'$.
- (6) Abutting land use: As required by Chapter 42 of the Code of Ordinances.

FIGURE 10.3

TYPICAL LENGTH OF MEDIAN AND MEDIAN OPENING



NOTES:

- (1) LTB-Left Turn Bay.
- (2) Distance from centerline of opening to median nose with left turn lane must be 30'.
- (3) See drawing titled ROADWAY TAPERS FOR SUBDIVISION STREETS.
- (4) Opening may be allowed, contact City Engineer.

TYPICAL LENGTH OF MEDIAN OPENING C

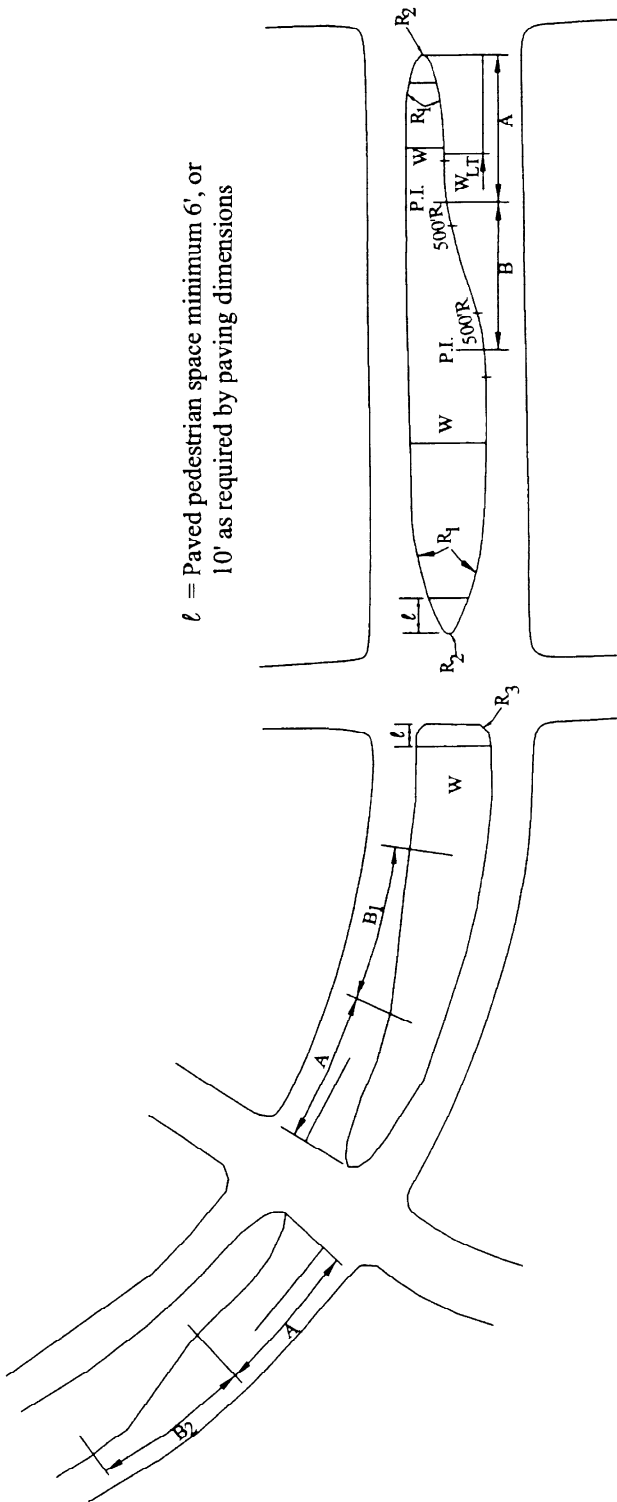
MEDIAN INTERRUPTION	NO LTb (1)	1 LTb (1)	2 LTb (1)
PRIVATE DRIVE	45'	52.5' (1)	60'
UNDIVIDED STREET ≤ 40' 44'	45' 50'	52.5' (2) 55' (2)	60' 60'
DIVIDED STREET ALL	D + 10'	D + 10'	D + 10'

MINIMUM ACCEPTABLE MEDIAN LENGTH FOR TYPE OF STREET (3)

IF PLANNED DIVIDED STREET IS:	PURPOSE OF MEDIAN INTERRUPTION		
	MAJOR STREET/ THOROUGHFARE (A)	COLLECTOR STREET (A)	PRIVATE STREET OR DRIVEWAY (B)
MAJOR STREET/ THOROUGHFARE	350'	300'	300' (4)
COLLECTOR STREET	300'	250'	250'
LOCAL STREET	250'	250'	200'

FIGURE 10.4

MEDIAN NOSE AND LEFT TURN BAY DESIGN



MEDIAN DIMENSIONS

W	R ₁	R ₂	R ₃
≤10'	NONE	$\frac{W}{2}$	NONE
>10'≤40'	90	$\frac{W}{5}$	NONE
>40'	NONE	NONE	15

LEFT TURN BAY DIMENSIONS

A = 150' minimum at intersection of two major streets.
= 100' minimum at all other intersections.
B = 100' minimum on straight roadway.
B₁ = Taper length may be shorter if it is on a horizontal curve to the left.
B₂ = Taper length may be longer if curve is to the right.
W_{LT} = 10' minimum
NOTE: Dimensions may be adjusted as determined by City Engineer.

FIGURE 10.5

INTERSECTION CORNER CUTBACK AND CURB RETURN DESIGN**CURB RETURN REQUIREMENTS**

TYPE OF INTERSECTION	90°	85° - 90°	80° - 85°
M - M	30'	35'	35'
M - D	30'	35'	35'
M - UD	30'	30'	30'
M - UDR	25'	30'	30'
D - D	30'	30'	35'
D - UD	30'	30'	35'
D - UDR	25'	30'	30'
UD - UD	25'	30'	30'
UD - UDR	25'	30'	30'
UDR - UDR	25'	30'	30'

RIGHT-OF-WAY CORNER CUTBACK REQUIREMENTS

1. Right Angle Intersection - 25 foot radius. (*)

2. Skewed Angle Intersection:

Acute angle - 25 foot radius.

Obtuse angle - 25 foot radius. (*)

(*) Sketch shows acceptable 15' property cutback as substitute for 25' radius.

TYPE OF INTERSECTION:

M - Designated major thoroughfares, and freeway service roads.

D - Divided roadways other than streets with major designation (M).

UD - Undivided roadways other than single family residential streets.

UDR - Undivided single family residential street.

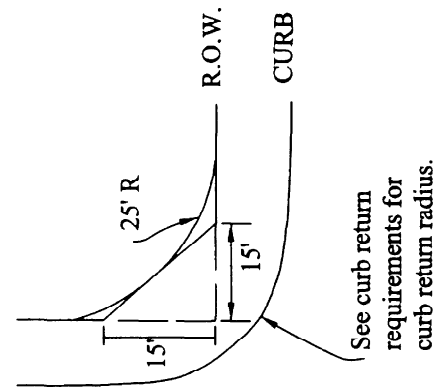


FIGURE 10.6

CUL-DE-SAC DESIGN FOR STREET TERMINATION

	ABUTTING LAND USE	
	SINGLE FAMILY	ALL OTHER
<i>A</i>	<i>All widths</i>	60'
<i>B</i>	<i>All widths</i>	40'
<i>C (Min)</i>	0	0
<i>C (Max)</i>	20'	15'
<i>D</i>	42'	50'
<i>E</i>	50'	60'
<i>F</i>	25'	25'
<i>G</i>	35'	35'

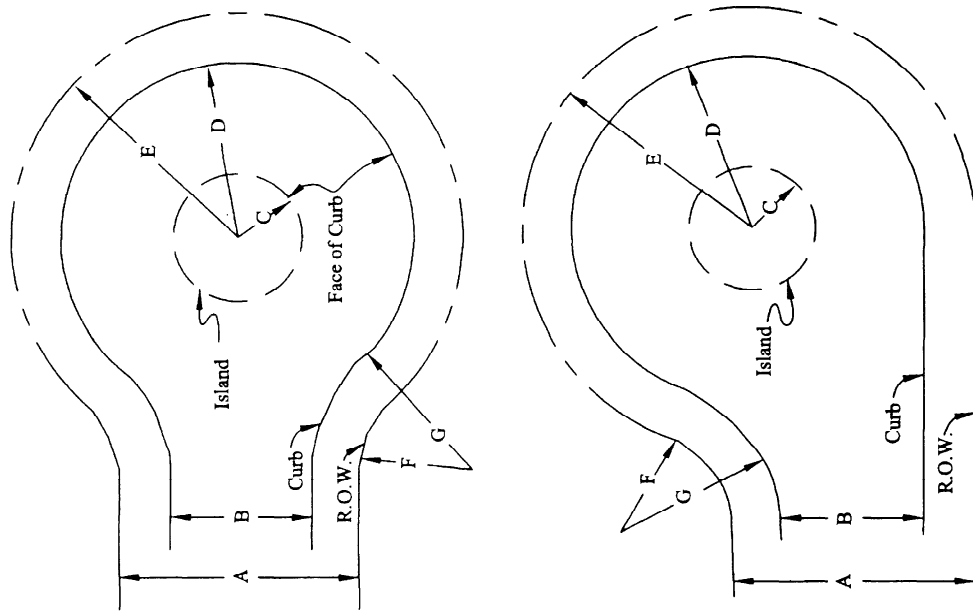
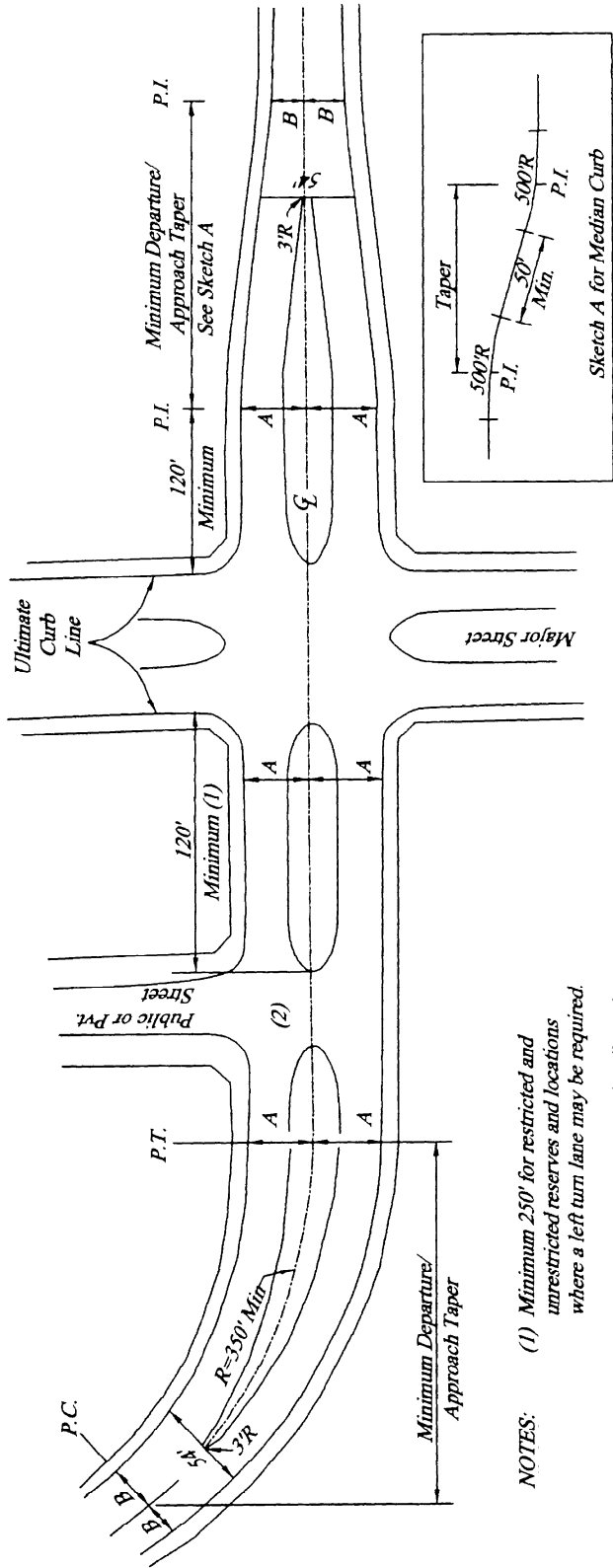
All dimensions measured in feet to face of curb.

FIGURE 10.7

ROADWAY TAPERS FOR SUBDIVISION STREETS



- NOTES:
- (1) Minimum 250' for restricted and unrestricted reserves and locations where a left turn lane may be required
 - (2) Median opening may not be allowed if median becomes less than 250' in length on major street.

- (3) Approach and Departure Taper Requirement:

$$L = \frac{WS^2}{60}$$
where L = length in feet
 S = speed in m.p.h.
 W = lateral offset in feet
 $S = 30$ m.p.h. minimum design speed for subdivision streets
 $W = A - B$
- (4) 350' minimum centerline radius for horizontal curve with approach or departure tapers

QUICK REFERENCE GUIDE

ROADWAY CROSS SECTION (FEET)		TAPER $L = \frac{WS^2}{60}$ (FEET)
A + A	B + B	
80	60	150
80	40	300
80	27	400
70	40	225
70	27	325
60	40	150
60	27	250
40	27	100

FIGURE 10.8

TYPE 2 PERMANENT ACCESS EASEMENT * - TERMINUS STANDARD

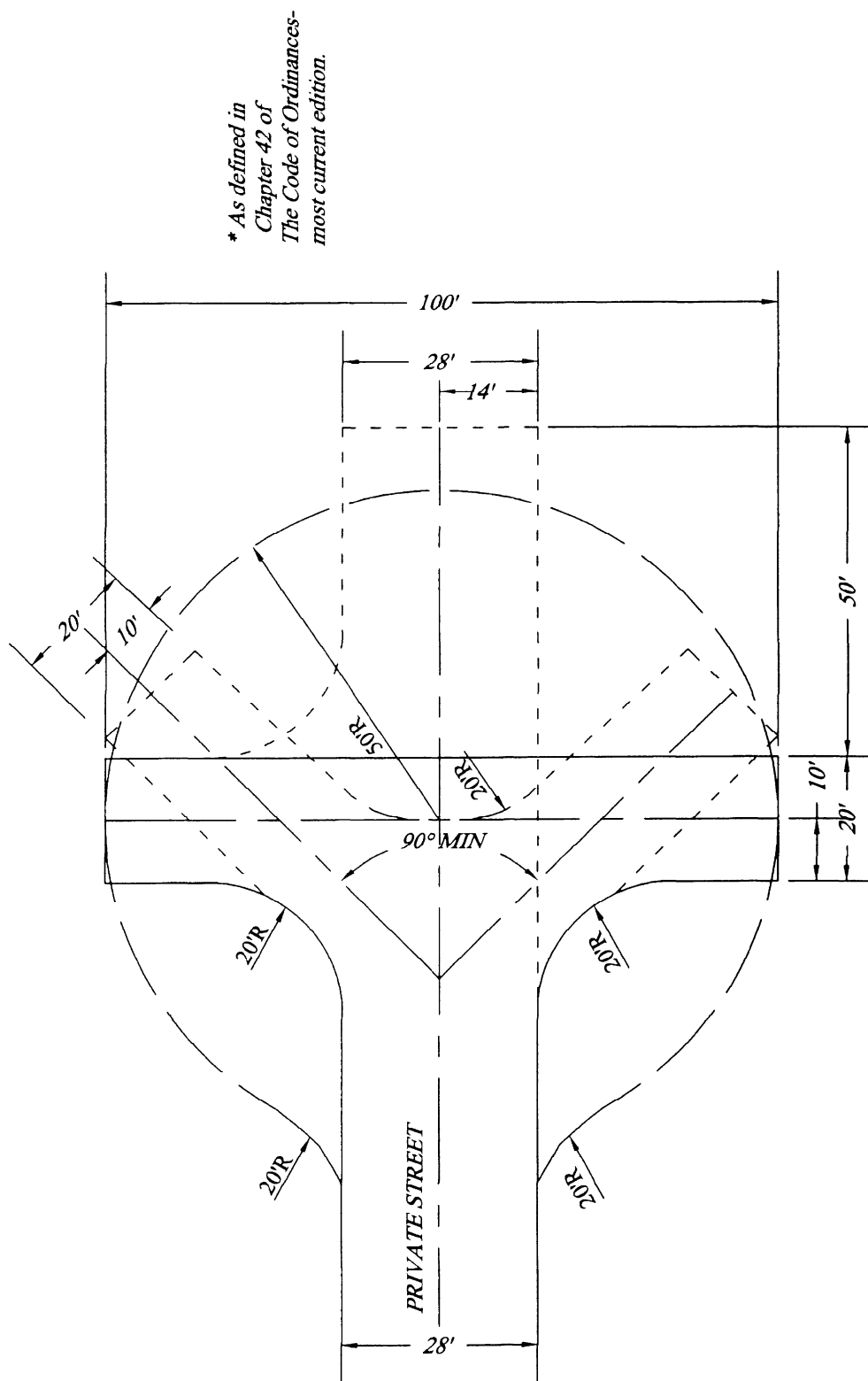
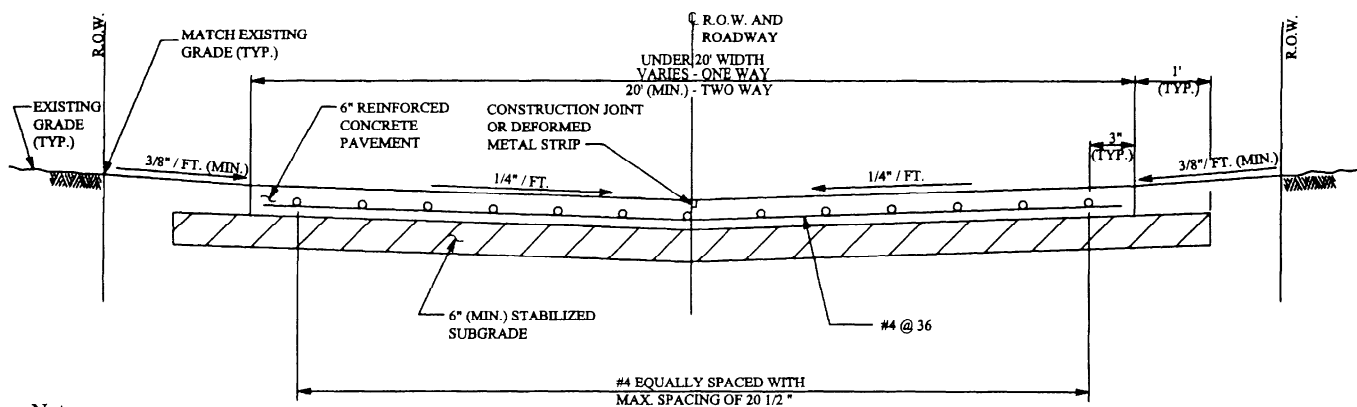
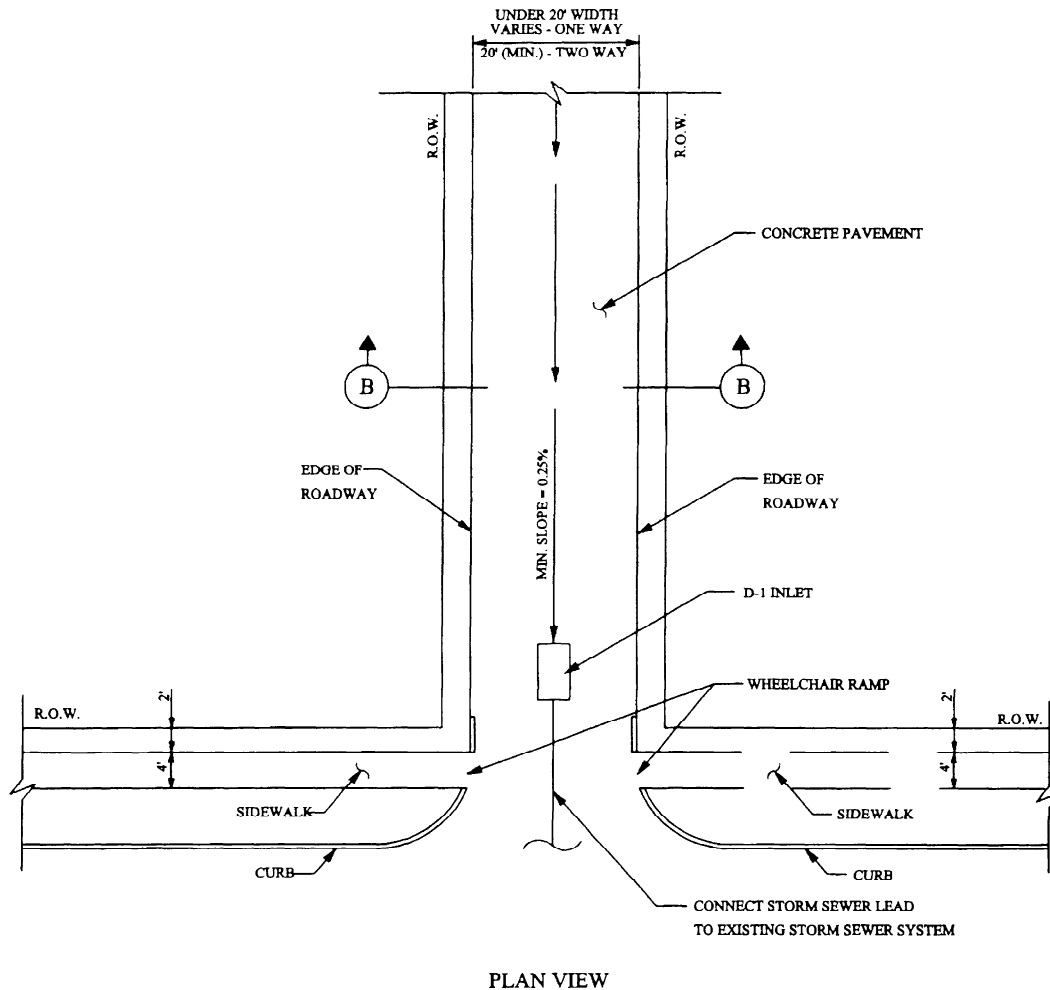


FIGURE 10.9
ALLEY PAVING
CURB AND GUTTER STREET



Notes:

1. Submit plan-profile in mylar.
2. Secure permit from paving section.
3. Intersections with public streets must be at right angles.
4. Internal drainage of the alley may be required so that flow does not cross the sidewalk into the street.
5. If sidewalks exist, the intersection of the alley with sidewalks must meet the provisions of the Architectural Barriers Act.

City of Houston

Design Manual

Chapter 11

GEOTECHNICAL REQUIREMENTS

Chapter 11

GEOTECHNICAL REQUIREMENTS

11.01 INTRODUCTION

- A. This chapter includes minimum geotechnical investigation requirements for design of utilities and streets. Utilities include water lines, wastewater systems, and storm water drainage conduits and open channels. Streets include design of street pavements.
- B. This chapter is not intended to address tunnel projects.

11.02 REFERENCES

- A. AASHTO - American Association of State Highway and Transportation Officials.
- B. AREA - American Railroad Engineering Association.
- C. ASTM - American Society for Testing and Materials.
- D. OSHA - Occupational Safety and Health Administration.
- E. TxDOT - Texas Department of Transportation, Foundation Exploration and Design Manual.
- F. TCEQ - Texas Commission on Environmental Quality.
- G. HGSB - Houston Geological Society Bulletin dated March, 1985.

11.03 INVESTIGATION REQUIREMENTS

- A. A geotechnical investigation is required prior to design for projects with following construction items. Data from earlier project design activities can be incorporated if sufficient and reliable for the current project. A geotechnical investigation by borings is required for design of:
 - 1. Underground utilities using open cut methods.
 - 2. Underground utilities to be augered beneath existing streets, pipelines, or other obstructions or structures.
 - 3. Street paving.

4. Construction which could affect the integrity of adjacent structures, with the exception of utilities at a depth less than 5 feet, interconnections such as service connections, and meter vault installations.
- B. Install piezometer when water-bearing layers indicate necessity for monitoring. |
1. Read water levels 24-hours after initial installation and at 30 days after installation. Abandon piezometers in accordance with TCEQ requirements. |
 2. Space piezometers no greater than 2500 feet apart. |
- C. The minimum geotechnical recommendations shall consist of the following:
1. Open-cut Trenches: Bedding, backfill, excavation wall and bottom stability, thrust restraint, ground water control requirements at boring locations, dewatering method, and flexible pipe design parameters.
 2. Auger Installation: Soil design parameters, ground stability, auger pit excavation stability, and dewatering recommendation.
 3. Appurtenance: Bearing capacity, lateral earth pressures, excavation stability, and dewatering.
 4. Open Channel: Slope angle or slope ratio, setback distance, and erosion protection.
 5. Paving:
 - a. For rigid paving, pavement thickness and minimum subgrade treatment, as required in Chapter 10, Street Paving Design Requirements.
 - b. For flexible paving, design Structural Number (SN), pavement section thickness, and subgrade treatment, as required in Chapter 10, Street Paving Design Requirements.
 - c. For overlay projects provide recommendations for rehabilitation.
- D. All projects requiring a geotechnical investigation shall include a reconnaissance fault study to evaluate the potential for known active faults that may impact the project. Conduct the investigation in accordance with HGSC recommendations. If the project is part of a larger tract for which a reconnaissance fault study is available, the results of the study on the larger tract may will satisfy this requirement. |
- E. For privately funded subdivisions in the City or subdivision developments in the ETJ, provide representative soil borings for all utility lines that conform to the spacing and number of

boring requirements of Paragraph 11.04. In cases where a development has conducted an area wide geotechnical investigation, borings that are located within 250 feet of the proposed lines may be used in lieu of specific project borings.

- F. Borehole sampling and testing for granular and cohesive soils shall include obtaining undisturbed Shelby Tube samples in cohesive soils and Standard Penetration Test Split-Barrel samples in granular soils, if not otherwise required in Paragraph 11.04. Continuous sampling shall be performed to a minimum depth of 10 feet, and at 5-foot intervals below that depth. Additional samples shall be obtained at strata changes encountered within the standard 5-foot sampling intervals.

11.04 INVESTIGATION CRITERIA

- A. The Following are minimum requirements for frequency and depth of borings for water main, sanitary sewer, storm sewer and box culvert projects.

1. Frequency: For Open-Cut construction and Auger Pits, soil borings shall be made at a spacing not greater than 500 feet with additional borings at closer spacing to better define areas of inconsistent stratigraphy. Make borings within an offset distance of no more than 20 feet from the centerline alignment of the utility line or at the location of the proposed structure.
2. Depth: For Open-Cut Construction, boring depths shall be:
 - a. Trench depth plus five feet for trenches up to 10 feet deep.
 - b. Trench depth plus ten feet for trenches from 10 to 25 feet deep.
 - c. One and one half times trench depth for trenches greater than 25 feet deep.
 Bore an additional 5 feet if the last planned sample is in water-bearing sand.
3. For Auger Pits, boring depth shall be auger pit depth plus five feet.

- B. Lift Station Projects.

1. In addition to spacing and boring depth requirements of Paragraph 11.04A, at least one boring must be made within 20 feet of the proposed center of a lift station. For lift stations 30 feet in diameter or larger, make one boring at the center; add borings around the periphery at maximum 50 feet spacing.
 - a. For City projects, the boring shall extend to:
 - (1) A depth of B below the bottom of the lift station, or
 - (2) A depth of $0.75 D$ below the bottom of the lift station, whichever is greater,
 where: B is the width or diameter of the lift station, and
 D is the depth of the lift station or excavation.

- b. For projects within the City's extra territorial jurisdiction (ETJ), the boring shall be to a minimum depth of 10 feet below the base of the structure.
 2. Install a piezometer within 20 feet of the center of the lift station. Read water levels 24 hours after drilling and again at 30 days after initial installation.
 3. Other Structures: The geotechnical engineer shall establish a A boring program in consultation with the owner and structural engineer.
- C. Open Channels.
 1. Soil borings shall be made at a spacing not greater than 500 feet with additional boring at closer spacing to better define areas of inconsistent stratigraphy.
 2. For channel a depth D of less than or equal to 10 feet, extend boring D feet below the ditch bottom.
 3. For channel depth greater than 10 feet and less than or equal to 20 feet, extend boring 10 feet below the ditch bottom.
 4. For channel depth greater than 20 feet establish boring depth to provide sufficient geotechnical information for design.
 5. Soils information for culverts in roadside ditches of less than five foot depth shall be obtained from soil borings made for the paving design, as described in Paragraph 11.04.D, Street Paving.
- D. Street Paving.
 1. Soil borings shall be made at a spacing not greater than 500 feet.
 2. The depth of borings shall be at least 5 feet below the top of the curb for curb-and-gutter sections and 5 feet below the crown of the road for open ditch sections, or 5 feet below ditch invert, whichever is greater.

11.05 LABORATORY TESTING PROGRAM

- A. Laboratory Tests may include but not be limited to the following:
 1. ASTM D 4318 - Liquid Limit, Plastic Limits and Plasticity Index of Soils.
 2. ASTM D 1140 - Amount of Material in Soils Finer Than the No. 200 Sieve.

3. ASTM D 2216 - Laboratory Determination of Water Content of Soil, Rock and Soil-Aggregate Mixture.
4. ASTM D 422 - Particle Size Analysis of Soils.
5. ASTM D 2487 - Classification of Soils for Engineering Purposes.
6. ASTM D 2166 - Unconfined Compressive Strength of Cohesive Soils.
7. ASTM D 2850 - Unconsolidated-Undrained Compressive Strength of Cohesive Soils in Triaxial Compression.
8. ASTM D 2435 - One-Dimensional Consolidation Properties of Soils.
9. ASTM D 698 - Laboratory Compaction Characteristics of Soil Using Standard Effort.
10. ASTM D 1883 - CBR (California Bearing Ratio) of Laboratory-Compacted Soils.

11.06 SURVEY REQUIREMENTS

- A. Within the public domain, the locations and elevations of boreholes and piezometers shall be surveyed by the Design Consultant. Elevation and coordinates shall be shown on boring logs. Station and offset shall be shown on boring logs for street projects and utility line work.

11.07 SITE RESTORATION

- A. Clean boring sites along the developed right-of-way by removing cuttings and mud and other debris. Fill ruts or pits in the ground to original conditions and elevation.
- B. Abandonment of Borings and Piezometers.
 1. Abandon piezometers abandon in accordance with TCEQ Rules
 2. Backfill boreholes with cement grout, using tremie method, if depth exceeds 10 feet or if water is encountered. For depths less than or equal to 10 feet, and when water is not encountered, soil backfill tamped into the borehole is acceptable. Boreholes or piezometers installed in known contaminated areas, or in which contamination otherwise has been detected, shall be abandoned in accordance with the applicable provisions of TCEQ Rules.
- C. Restoration of Cores Through Pavement. Boreholes or other cored penetrations of pavements shall be restored with the same or equivalent materials as the existing pavement. Larger penetrations shall be repaired following City of Houston Standard Detail No. 02902-01,

Pavement Repair Details. Do not restore the pavement until the borehole grout has taken initial set to allow for any settlement or shrinkage of the grout.

11.08 GEOTECHNICAL REPORT

A. A sample Table of Contents for a typical geotechnical report follows:

1. Summary
2. Field Investigation and Laboratory Testing
3. Subsurface Conditions
4. Engineering Analysis and Recommendations
5. Construction Considerations
6. Attachments

B. When directed, a geotechnical report for trench safety system shall be provided for a specified City of Houston projects. Report shall satisfy statutory requirements for contracting for trench safety construction.

END OF CHAPTER

City of Houston

Design Manual

Chapter 12

STREET CUT REQUIREMENTS

Chapter 12

STREET CUT REQUIREMENTS**12.01 CHAPTER INCLUDES**

- A. Criteria for street pavement cuts, excavation, backfill, and pavement restoration in Public Ways.
- B. This chapter applies to excavation under paved surfaces in Public Ways which have been improved for street, sidewalk, surface drainage, or related public transportation infrastructure.

12.02 REFERENCES

- A. Refer to the list of references in Chapter 1, General Requirements.
- B. City of Houston Procedural Guidelines for Planning and Permitting of Excavations in Public Ways, latest revision.

12.03 DEFINITIONS

- A. Excavation - An activity that disturbs, alters, or penetrates any portion of the public way that has been improved for street, driveway, sidewalk, surface drainage, or related public transportation infrastructure purposes. The term includes but is not limited to cutting, tunneling, jacking and boring, backfilling, restoring, and repairing the public way. The term does not include a transportation improvement; however, it does include excavations that are undertaken for the improvement or maintenance of publicly owned utility systems, such as water and wastewater lines and facilities.
- B. Backfill - Excavation fill material that meets city specified quality requirements or the placement thereof.
- C. Facility - Any structure, device, or other thing whatsoever that may be installed or maintained in, on, within, under, over or above a public way by an excavation.
- D. Five-Year CIP - Street improvement projects included in a Capital Improvement Program by the City of Houston, Harris County, METRO, TxDOT, or other organization for construction.
- E. Hole - Excavation in the Public Way with the excavation having a length less than the width of the pavement.

- F. Patch - Method of pavement replacement that is temporary in nature. A patch consists of: (1) the compaction of the subbase and aggregate base, and (2) the replacement, in kind, of the existing pavement for a minimum of two feet beyond the edges of the excavation in all directions. A patch is full restoration only when the pavement is included in the City of Houston's Five Year Capital Improvement Plan.
- G. Public Way - Any public street right-of-way located in the city, including the entire area between the boundary lines of every way (including but not limited to roads, streets, alleys, highways, boulevards, bridges, tunnels, or similar thoroughfares), whether acquired by purchase, grant, or dedication and acceptance by the city or by the public that has been opened to the use of the public for purposes of vehicular travel.
- H. Restoration - The process by which an excavated public way and surrounding area, including pavement and foundation, is returned to the same condition that existed before excavation.
- I. Trench - An excavation in the pavement with the excavation having a length equal to or greater than the width of the pavement.

12.04 DESIGN REQUIREMENTS

- A. Design project so that restoration returns public way to the same condition that existed prior excavation. Base minimum limits and methods required for restoration on City Standard Details.
- B. Comply with requirements of 6.08A., Open Cut Construction in Street Pavement, for all open-cut construction including excavation for auger or directional drilling insertion pits.
 - 1. Saw cut existing pavements along lines parallel to and perpendicular to traveled way center lines unless otherwise approved by the City Engineer.
 - 2. For concrete pavements, conform to requirements of Paragraphs 10.04, K., 5., 10., and 11.
- C. Prepare plan view drawings for all excavations that identify and locate existing underground facilities. The drawings, or verification statements, shall confirm that the underground facilities have been identified, located, and marked by the following organizations:
 - 1. Texas Underground Facility Notification Corporation,
 - 2. City of Houston Public Utilities (water and sewer), and
 - 3. City of Houston Traffic Signal Section.

- D. The City may require plan and profile drawings for complex projects or when the constructing agency has demonstrated previous non-compliance with underground facility location procedures.
- E. Plan view drawings shall show, at a minimum, the following information for the project area:
 - 1. Topographical features.
 - 2. Existing public and private utilities.
 - 3. Significant landscaping or other structures which might impact construction or construction related activities.
 - 4. Location and dimensions of proposed surface cuts.
 - 5. Location and depth of existing and proposed mains, cables, conduits, switches, and related equipment and facilities.
 - 6. Use baseline offsets from property lines, centerline of the public way, or curb lines; or a coordinate system acceptable to the City.
- F. Final drawings shall include a list City of Houston Standard Specifications and related standard details for excavation, bedding, backfilling and pavement repair and resurfacing.

12.05 QUALITY ASSURANCE

- A. For projects which include conduits, duct banks or pipelines over 1", have final design drawings sealed, signed, and dated by the Professional Engineer responsible for development of the drawings.

END OF CHAPTER

City of Houston

Design Manual

Chapter 13

STORM WATER QUALITY DESIGN REQUIREMENTS

Chapter 13

STORM WATER QUALITY DESIGN REQUIREMENTS

13.01 CHAPTER INCLUDES

- A. Criteria for the design of storm water pollution prevention procedures and controls for construction activities.
- B. Criteria for the design of permanent storm water pollution prevention procedures and controls to minimize impacts for new development and decrease impacts for redevelopment on tracts of land of 5 acres or more.

13.02 REFERENCES

- A. Storm Water Quality Management Guidance Manual, 2001 edition, City of Houston.
- B. Storm Water Management Handbook for Construction Activities, 2001 edition, City of Houston.
- C. Select Minimum Design Criteria for Implementation of Best Management Practices for Storm Water Runoff Treatment, 2001 edition, City of Houston.
- D. Article XII of Chapter 47 of the City of Houston Code of Ordinances.
- E. National Pollution Discharge Elimination System Permit Number TXS001201.

13.03 DEFINITIONS

- A. Dwelling Unit - A structure, or a portion of a structure, that has independent living facilities including provisions for nontransient sleeping, cooking and sanitation.
- B. Impervious Surface - Any area that does not readily absorb water, including, but not limited to, building roofs, parking and driveway areas, sidewalks, compacted or rolled areas, and paved recreation areas.
- C. New Development - Development on a currently undeveloped parcel of land five acres or larger without regard to the amount of land that will actually be disturbed, except for development on an existing undeveloped and undivided parcel of five acres or more of one single-family dwelling unit and/or the types of non-commercial building(s) typically associated with a single-family dwelling unit, including, but not limited to, a garage, carport or barn. If the occupancy for any structure excluded under the foregoing exception at any time

changes to a commercial use, the owner of the property will at that time have to comply with all requirements of this program.

- D. Significant redevelopment - Changes of one acre or more to the impervious surface on a five acre or larger developed parcel.
- E. Applicant - The owner of the land on which the new development or significant redevelopment will occur, or his authorized agent.
- F. NPDES - National Pollutant Discharge Elimination System.
- G. SWQMP - Storm Water Quality Management Plan.
- H. Regulated Construction Activity - Construction activities, including clearing, grading, and excavation, that disturb either five acres or more, or less than five acres if the activities are part of a larger plan of development or sale.

13.04 DESIGN REQUIREMENTS

A. Construction Activity:

1. Storm Water Pollution Prevention Plans (SWPPPs) and Best Management Practices (BMPs) will be developed in accordance with the Storm Water Management Handbook for Construction Activities.
2. Construction plans will include a note requiring contractor to comply with construction permit including preparation of a SWPPP and to provide a copy of the Notice of Intent (NOI) and maintenance checklist to the City 5 work days prior to commencement of any construction activity to City Engineer or Building Official.

B. New Development and Significant Redevelopment:

1. All design must be consistent with the Storm Water Quality Guidance Manual (SWQGM) and the Minimum Design Criteria for Certain Storm Water Runoff Treatment Options (MDC), 2001 edition.
2. A letter of availability must be included with the Storm Water Quality Management Plan
3. Pollutants expected from the site must be identified. BMPs must be designed and selected to remove the pollutants identified.
4. At a minimum, the system must be designed to treat the first 1/2 inch of runoff, except as noted in the SWQGM or the MDC.

5. BMPs listed in the SWQGM but not in the MDC may be acceptable for implementation pending review of design calculations and site applicability. BMPs not listed in the SWQGM may be considered on a case by case basis. Acceptance of these BMPs will require not only review of design calculations and site applicability, but also review of case studies or other data provided by an uninterested third party indicating the effectiveness of the BMP. All calculations and literature must be provided as part of the plan submittal.
6. In addition to meeting the storm water quality requirements discussed in the Design Manual Chapter 13 and its referenced documents, the storm water system must meet the flood control requirements presented in Chapter 9 of the Design Manual.

13.05 QUALITY ASSURANCE

- A. Final design drawings, BMPs, SWPPPs, and SWQMPs will be sealed, signed, and dated by the Professional Engineer registered in the State of Texas responsible for their development.

END OF CHAPTER

City of Houston

Design Manual

Chapter 14

FACILITY DESIGN REQUIREMENTS

Chapter 14

FACILITY DESIGN REQUIREMENTS

14.01 CHAPTER INCLUDES

- A. Incorporation of Public Works and Engineering Manuals and Guidelines for water and wastewater related facilities.

14.02 REFERENCES

- A. Water Plant Guidelines
- B. Engineering Design Manual for Submersible Lift Stations.
- C. Drawings for Submersible Lift Stations.

14.04 DESIGN REQUIREMENTS

- A. Conform to design requirements of the latest published edition of each reference manual.

END OF CHAPTER